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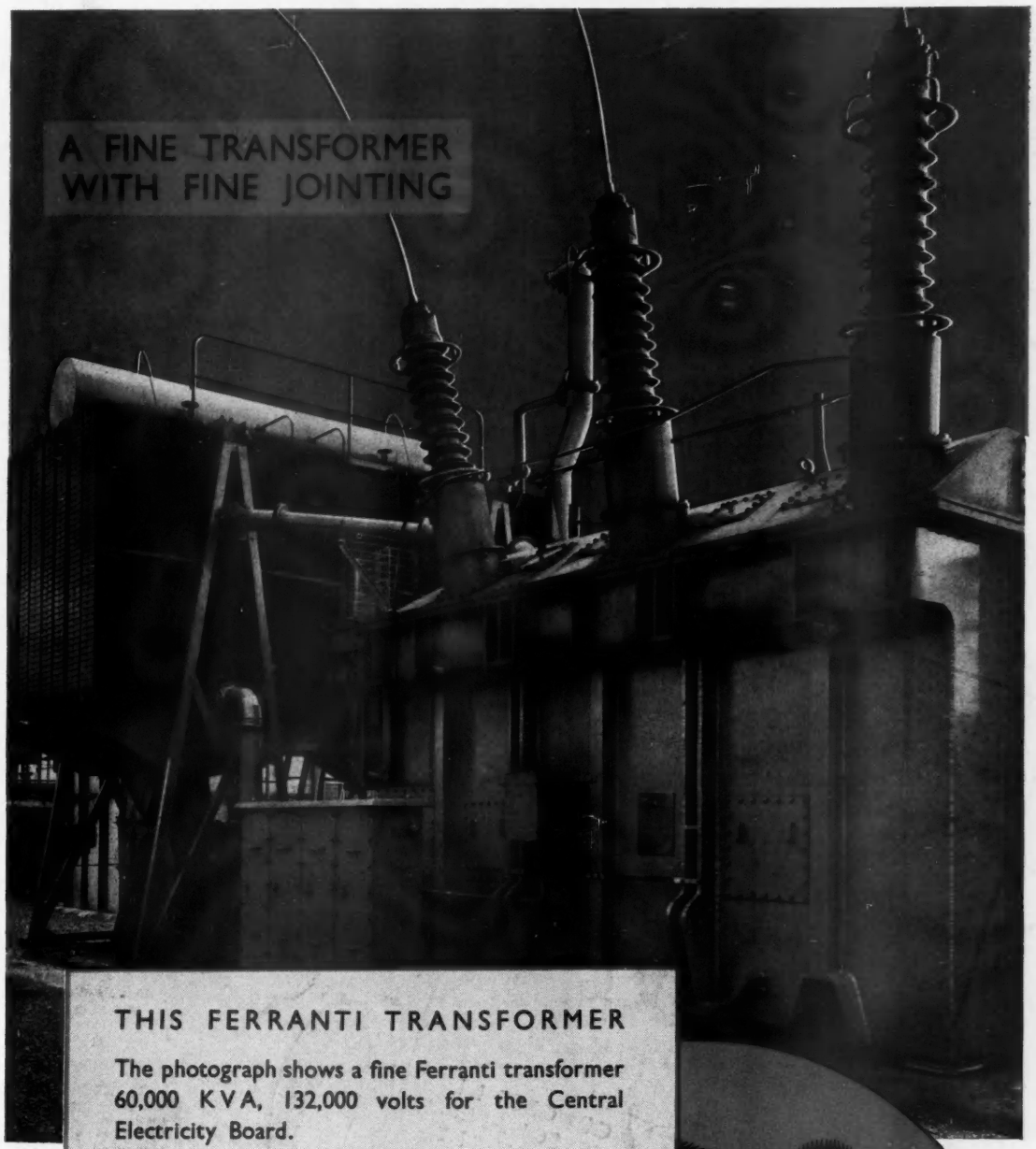


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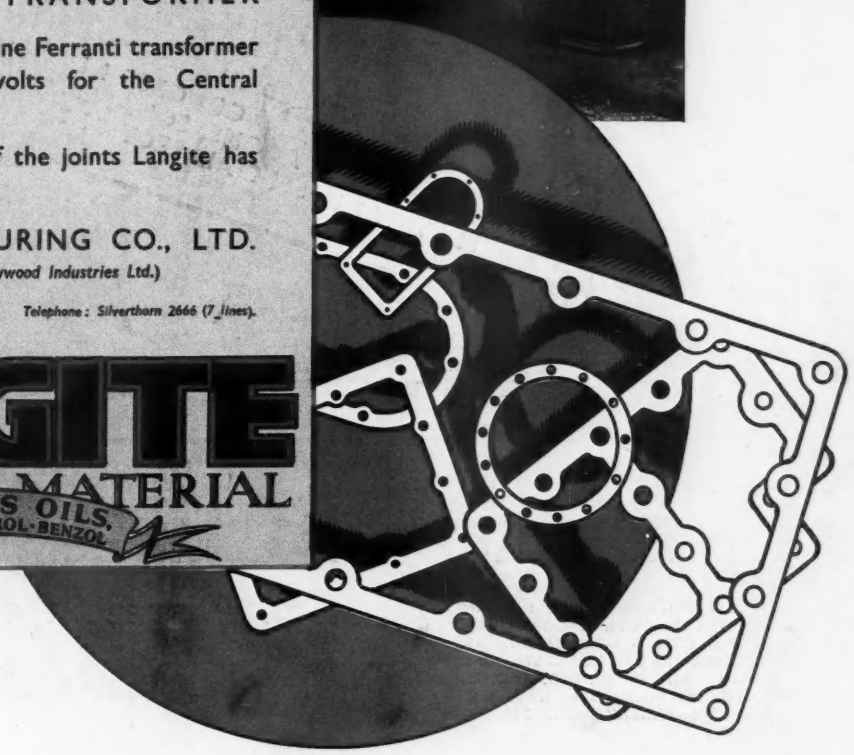

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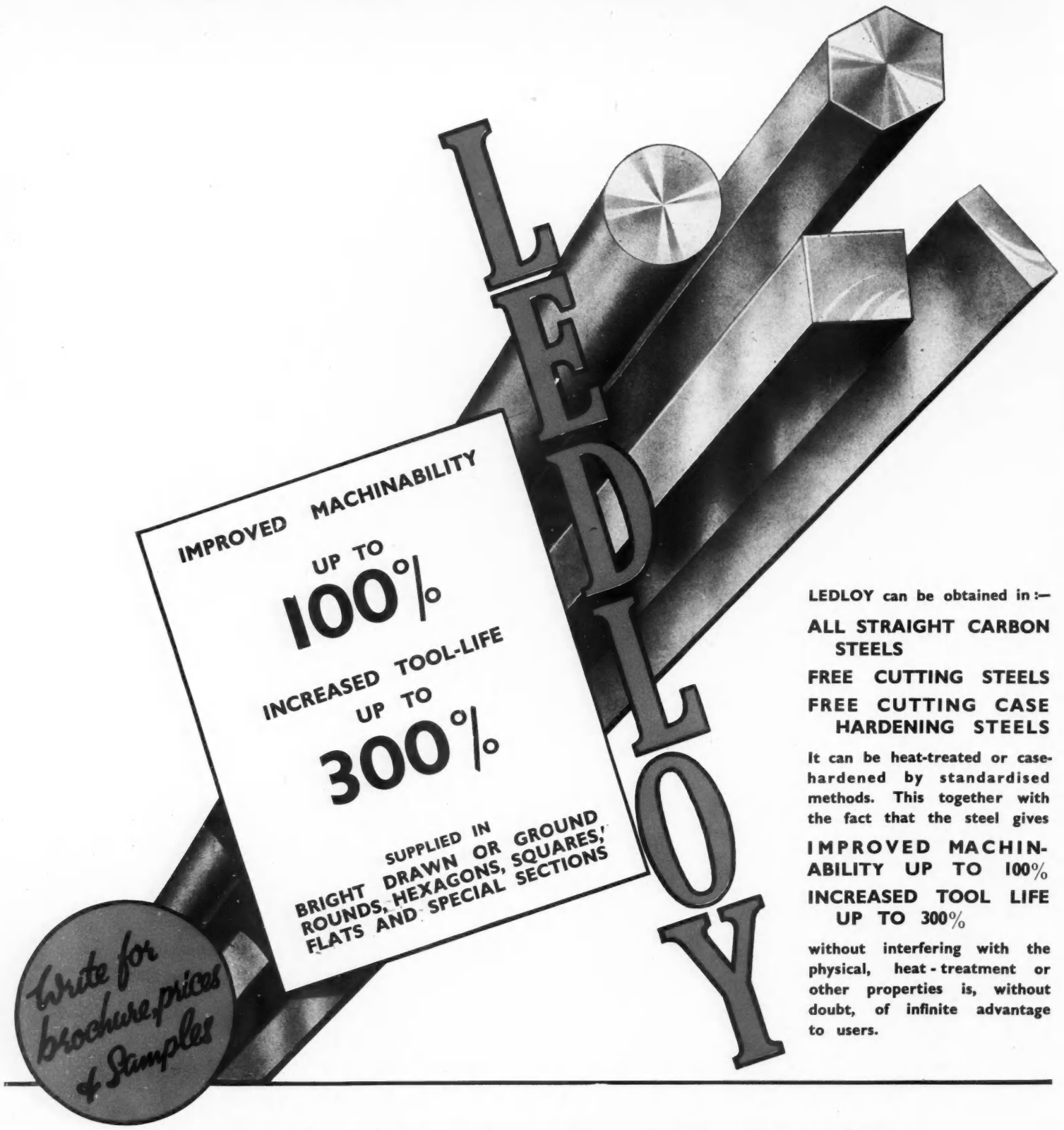


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# A Seven-Day Journal

## Economic Warfare

ARRANGEMENTS for putting into practice that co-ordination of the economic war efforts of the United Kingdom and France, which the British and French Prime Ministers announced on November 17th, have now been completed. Last Monday it was announced that the chairman of the Anglo-French Co-ordinating Committee would be M. Jean Monnet. The members of this Committee will vary in accordance with the particular subject under discussion at any time, and will be drawn from a panel consisting mainly of the senior members of the Permanent Executive Committees which will operate under the control of the Co-ordinating Committee. The function of the latter Committee will be to co-ordinate the work of the others and it will deal with any difficulties arising out of the supply and purchase of munitions, food, coal, and other commodities, or which raise questions of principle or priority, and also co-ordinate the work of Allied Purchasing Missions abroad. The co-ordination of purchases of aircraft and armaments in Canada and the United States has already been arranged. In Canada orders from Britain or France will be placed through a Canadian War Supply Board, whilst in the United States existing British and French Missions have been placed under the direction of an Anglo-French Board of which Mr. Arthur Purvis has been appointed chairman. Broad issues of policy to be followed by the various co-ordinating committees will, of course, be settled by the Supreme War Council. During the last war M. Monnet represented the French Government on various Allied organisations and was a member of the Inter-Allied Maritime Transport Committee. Mr. Arthur Purvis is president and managing director of Canadian Industries, Ltd., the Canadian connection of Imperial Chemical Industries.

## Industrial Population

IN July of each year a count is made of the industrial population. Latest figures now issued by the Ministry of Labour show that last July there were 14,838,000 persons between the ages 14 and 64 insured in Great Britain under the general scheme, and another 710,000 under the agricultural scheme. Including Northern Ireland the figures are increased to 15,157,400 and 740,900 respectively. For the general scheme, as applied to Great Britain and Northern Ireland, an increase during the 12-month period of 164,900 or 1·1 per cent. is shown, whilst in the agricultural group there was a decrease of 9450 or nearly 1·3 per cent. Increases occurred mainly in the adult group. There were 70,200 more men and 24,800 more women between the ages 21 and 64, and 83,900 more young men and 98,500 more young women between the ages 18 and 20 in the general scheme. But the number of boys of 16 and 17 decreased by 52,100 and those of 14 and 15 by 21,000. Girls in the corresponding age groups decreased in number by 23,300 and 16,100 respectively. The variations in the numbers under 21 are, it is stated, influenced by changes in the birth rate between 1917 and 1925. Since 1927 the number of insured persons in the general scheme has increased by nearly 2,500,000 in Great Britain. Of this increase 220,000 occurred as the result of extensions of the range of insurance.

## National Co-ordination of Science

IN the annual report of the Executive Committee of the Association of Scientific Workers attention is directed to the need for the co-ordination of scientific work in this country. A memorandum has been prepared on the subject and was issued with the report. It is pointed out that scientific work is carried out in this country by a variety of institutions, including the Service departments, industrial firms, the Department of Scientific and Industrial Research, universities, and institutes and laboratories which owe their existence to special endowments. At the present time the Service departments are expanding their personnel greatly. But while some industrial laboratories are in active use others have been neglected since the outbreak of war. There appears to be a danger that certain of these laboratories may be closed down as they no longer appear immediately profitable and at a later date they might have to be laboriously re-constituted. In the cases of other research and development laboratories reports reaching the Association have shown that there is a serious lack of direction and a considerable amount of overlapping. At least six university laboratories have been closed down and in the case of at least two Research Associations the work has been slowed down owing to lack of support for the continuation of the peace-time programme. The Association considers that many laboratories are waiting for a lead and that unless it is forthcoming many of them may not survive. To quote from the Memorandum, "What appears to be required is a body, armed with powers and resources resembling those of the State Departments, organising labour and supply to ensure the pooling of knowledge and the rational allocation of scientific work. This body must be able to shift emphasis to the point at which it is most needed and to decide when to discontinue lines of work and when to initiate fresh ones. It should ensure adequate co-ordination between all units concerned, and the flow of discussion and free criticism essential for scientific progress while maintaining adequate safeguards of secrecy. This Association is not competent to lay down the organisation of such a department but it believes that scientific organisations should jointly approach the Government with the proposal that an *ad hoc* committee should be set up to draft a scheme for such a constitution."

## United States Navy

IN the annual report of the Acting Secretary of the U.S. Navy, Mr. Charles Edison, there is a recommendation that more ships should be built and that the number of men should be increased. It is urged that the present international situation requires that there should be an acceleration of the construction programme. A particular need appears to be that of auxiliary ships and the officer personnel is still apparently short by nearly 1000 men even of present requirements. At the beginning of July 105 ships were under construction, of which 80 are described as combat vessels. Included in this number are 8 battleships of 35,000 tons displacement, to which there will shortly be added 2 of 45,000 tons displacement, 2 aircraft carriers, 5 light cruisers, 20 submarines, 42 destroyers, 3 submarine chasers, and tenders, minelayers, and minesweepers. The commissioned fleet during the year covered by the report consisted of 15 battleships, 3 of which were under reduced commission, 18 heavy cruisers, 18 light cruisers, 121 destroyers and light minelayers, 58 submarines, and 5 aircraft carriers and auxiliaries.

## Priority Schemes

ON Thursday of last week Colonel J. J. Llewellin, Parliamentary Secretary to the Ministry of Supply, gave some particulars of the working of the priority schemes. He pointed out that the proper allocation of productive capacity and raw materials was the only basis on which a successful war could be carried on. He was supervising head of the central priority committee and there were five sub-committees dealing respectively with materials, productive capacity, labour, transport, and works and buildings. His first action when the risk of war became grave was to call a general meeting which began just 10 minutes before the time fixed for the outbreak of war. His object was to see that all the sub-committees worked on parallel lines. For it was apparent to him that if priority certificates had been issued in any wholesale manner for Government requirements our export trade would have suffered very severely. Through the appointment of controllers the Ministry had so far been able to dispense with the issue of any certificates, and the controllers had been able to deal with all demands made upon them and had exercised their powers with common sense and fairness. In the allocation of commodities the demands of the Services and the home and export trade had to be considered and provision had to be made to meet emergency conditions. Some shortage had been felt in certain commodities because of the need to direct supplies for use in the manufacture of materials urgently required. The fixing of maximum prices of raw materials had prevented prices rising above those which higher shipping freights and insurance justified, but the price level might still have to rise a little.

## Retirement of Mr. Raymond Carpmael

IT is announced that Mr. Raymond Carpmael, who since 1929 has occupied the post of chief engineer of the Great Western Railway, will retire from that position at the end of the year. He will be succeeded by Mr. Allan Quartermaine, who for some years has acted as assistant chief engineer, and more recently deputy chief engineer. Mr. Carpmael who is in his sixty-fifth year was educated privately, and at Dulwich College, and in 1900 entered the service of the Great Western Railway Company, in the Bridge Department at Paddington. The following year he was appointed assistant engineer on the Harbour Works at Fishguard, on which work he was engaged until 1908, becoming successively chief assistant and resident engineer. From 1909 to 1916, he was chief assistant on the Shrewsbury Division. The same year he was appointed to the Gloucester Division where he again served as chief assistant, and in 1917 he was senior engineer-in-charge of No. 3 G.W.R. Civilian Railway Company. In 1919 he became divisional engineer at Shrewsbury, where he stayed until 1922 when he was appointed to Neath. Two years later he was made assistant to the joint chief engineers at Barry Docks and in 1926 returned to Paddington to take up the appointment of assistant chief engineer, and was raised to the position of chief engineer in 1929. He is a member of the Institutions of Civil and Mechanical Engineers, the Institution of Structural Engineers, a Fellow of the Permanent Way Institution, and a member of the British Section of the Ingenieurs Civil de France, Transport. He is Colonel Engineer and member of the Railway Staff Corps., T.D. (R.E.). Mr. Allan Quartermaine, who succeeds Mr. Carpmael, was formerly divisional engineer at Bristol, and for many years has worked with Mr. Carpmael at Paddington as assistant and more recently as deputy chief engineer. He is a member of the Institution of Civil Engineers.

## The Shipbuilding Employers' Federation

AT the Annual General Meeting of the Central Board of the Shipbuilding Employers' Federation held in Carlisle on Friday, November 24th, Mr. Henry Main, the managing director of the Caledon Shipbuilding and Engineering Company, Ltd., of Dundee, was elected President for the coming year in succession to Mr. A. M. Stephen, the Chairman of Alexander Stephen and Sons, Ltd., of Linthouse, Glasgow. Mr. J. M. Ormston, the Shipbuilding Manager of Vickers-Armstrongs, Ltd., of Barrow-in-Furness, becomes the Senior Vice-President, while the second Vice-President is Mr. G. S. Cromar of Barclay, Curle and Co., of Glasgow. The vacancy amongst the Vice-Presidents arising from Mr. Henry Main's promotion to the Presidency, has been filled by the appointment of Mr. H. B. Robin Rowell, shipyard manager and director of R. and W. Hawthorn Leslie and Co., Ltd., of Hebburn-on-Tyne. Mr. J. G. Stephen, yard manager and director of Alexander Stephen and Sons, Ltd., of Linthouse, Glasgow, was elected Chairman of the Conference and Works Board of the Federation, with Mr. E. W. R. Pinkney, director of Swan, Hunter and Wigham Richardson, Ltd., as Vice-Chairman.

## The "Rawalpindi" Sunk

THE first surface naval action of the war took place on November 23rd, and resulted in the sinking of the former P. and O. liner "Rawalpindi." On the outbreak of war the "Rawalpindi," a ship of 16,697 tons, built by Harland & Wolff at Greenock, and completed in 1925, was taken over by the Admiralty for use in contraband control duty in the stormy waters off the coast of Iceland. She became an armed merchant cruiser and carried a number of 6in. guns on her broadsides. She was manned by merchant seamen, reservists, and pensioners of the Royal Navy, and by men of the R.N.R. and R.N.V.R., the total crew numbering some 300 men. At 3.30 p.m. on Thursday, November 23rd, an enemy ship was sighted and recognised as the German "pocket battleship," "Deutschland," which was known to be operating in the Atlantic, but whose precise position had been doubtful for some time. Faced by a fully equipped warship carrying 11in. guns on a "Washington" displacement of 10,000 tons the "Rawalpindi" had little chance of fighting a successful action. Smoke-floats were lit and cast into the water to conceal the escape of the ship, but did not succeed in their purpose. The "Deutschland," which appears to have been accompanied by another unidentified ship, fired a shot across the bows of the "Rawalpindi," and when she continued on her course brought her 11in. guns to bear. The "Rawalpindi" maintained the fight until all her 6in. guns had been put out of action. By that time she was seriously on fire, and between 4.15 and 4.30 p.m. the "Deutschland" ceased fire and proceeded to pick up survivors. About 6 o'clock a British cruiser appeared on the scene and caused the German vessels to withdraw. The "Rawalpindi" remained afloat until about 8 o'clock, when she sank.

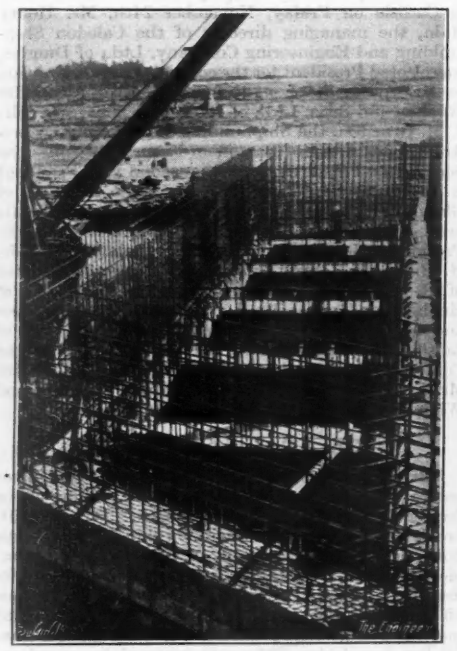
## British Overseas Airways Corporation

ON Monday, November 27th, it was officially announced by the Air Ministry that the Secretary of State for Air has now established the British Overseas Airways Corporation, which was provided for under the British Overseas Airways Act of 1939, and has appointed Sir John Reith, Mr. Clive Pearson, and Mr. Leslie Runciman as members. Sir John Reith has been appointed the chairman of the Corporation, and Mr. Clive Pearson will be the deputy-chairman. It will be the duty of the Corporation to ratify the provisional contracts for the purchase of the undertakings of Imperial Airways and British Airways, and generally to complete the necessary formalities for taking over these undertakings on the appointed day. Under the terms of the Act, the Corporation was to consist of a chairman, deputy-chairman and not less than nine or more than fifteen members, with the proviso that the Corporation might be deemed to have been established when the chairman, the deputy-chairman, and five other members had been appointed. In the circumstances of war, however, it is not necessary to establish a Corporation with so large a membership. Accordingly in the interests of economy and efficiency, advantage was taken of the Chartered and Other Bodies (Temporary Provisions) Act, which received the Royal Assent on November 16th, to provide, by Order-in-Council, that the Corporation may be established with three members only.

# Lions Gate Bridge at Vancouver

VANCOUVER, British Columbia, has had in service since November, 1938, a suspension bridge across the entrance to the inner harbour that has cost a total of 5,700,000 dollars. The completion of that structure has brought to fulfilment efforts to span the First Narrows that were recurrent over a period of forty-seven years before actual work was started on the present structure.

The city of Vancouver is situated on the south shore of Burrard Inlet, which extends in a generally east and west direction for about 10 miles and has



NORTH MAIN FIER CAISSON

a maximum width abreast the municipality of 2⅓ miles. Within the limits of the city's boundary, the opposite shores of the inlet approach each other to within about half a mile and these passages are known as First Narrows and Second Narrows, respectively. The Second Narrows, near the eastern border of Vancouver, has been bridged for some years by a structure used by a connecting railway, vehicles, and pedestrians, but for general traffic it is somewhat out of the way. Vancouver, on the south shore, and North Vancouver, on the north shore, have therefore been more directly served by two ferry lines plying between the two sides of the inlet—the ferries transporting both passengers and vehicles.

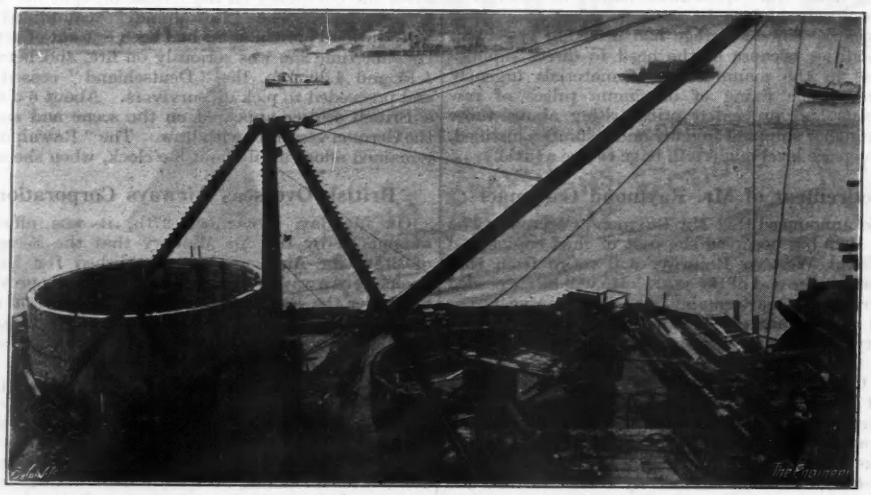
The growth of Vancouver, the upbuilding of North Vancouver, and the recently rapid development of West Vancouver have together brought about a situation that has repeatedly overtaxed the accommodation available aboard the ferries, especially at peak hours, on holidays, and during the tourist season, which attracts to Greater Vancouver and its exceptionally scenic surroundings a large influx of visitors. The Lions Gate bridge is the engineering solution of the difficulty. It is a toll crossing that has been built by the First Narrows Bridge Company, Ltd., and the structure, fifty years hence, may be purchased by the city of Vancouver on the basis of its value at that time. The southern end of the bridge is on the high shore of Stanley Park, but the northern end is on the Capilano delta, where the ground is low.

Construction of the Lions Gate bridge was authorised by the Dominion Government on April 30th, 1936; and the initial contract for the steel work was let on January 21st, 1937. A little less than six months subsequently the first ground was broken for construction. The centre of the city is linked with the bridge by a highway, 30ft. wide and concrete paved, that traces a widely curved course for about 1¼ miles through the picturesque and heavily timbered expanse of Stanley Park. At its city end this new road terminates in a grade separation structure, where most of the other park roadways converge. At night this highway is illuminated by sodium vapour lamps.

From the shore of Stanley Park northward, across the First Narrows, to the Capilano delta side of the harbour's mouth, the crossing is composed of two side spans, each 614ft. in length, and a central main span that has a length of 1550ft. from centre to centre of the two sustaining towers. The north end of the north side span, at the crown of the roadway, is at an elevation of about 162ft. above the surface of the underlying ground, and from that point northward, for a distance of 2196·5ft., the roadway is carried on a steel approach viaduct that has a gradient of 4·836 per cent. The viaduct terminates at a reinforced concrete abutment, where the roadway is about 40ft. above the ground, and from that junction northward for 1023ft. the roadway continues on a gravel embankment until it reaches the Marine Drive or passes over that beautiful shore route by a grade separation structure. From the south end of the south anchorage structure to the abutment at the northernmost end of the steel approach viaduct the Lions Gate bridge has a total length of 5074·5ft. The toll station is on the gravel embankment, about 200ft. to the south of the Marine Drive intersection.

The tidal range at the First Narrows is 13ft. between low and extreme high water; and at mid-channel, for a longitudinal distance of 200ft., the main span affords an under-clearance of 209ft. at the highest stage of the tide. The two main towers of the suspended structure rise to a height of about 382ft. above the water, at high tide, at the cable intersections. Each main tower is set upon a reinforced concrete pier that has the tops of its twin pylons approximately 17·75ft. above extreme high water. The base line of the foundation for the north pier is at a depth of 79·77ft. below the level of maximum high water, while the foundation of the south pier rests at a depth of 56ft. below high water. The north pier is grounded in gravel and rises from ground that is bared except at high water. The south pier, on the contrary, is situated offshore about 150ft. and its base structure is always submerged. This pier rests on rock.

PART OF SOUTH ANCHORAGE



SINKING CAISSONS FOR SOUTH MAIN PIER

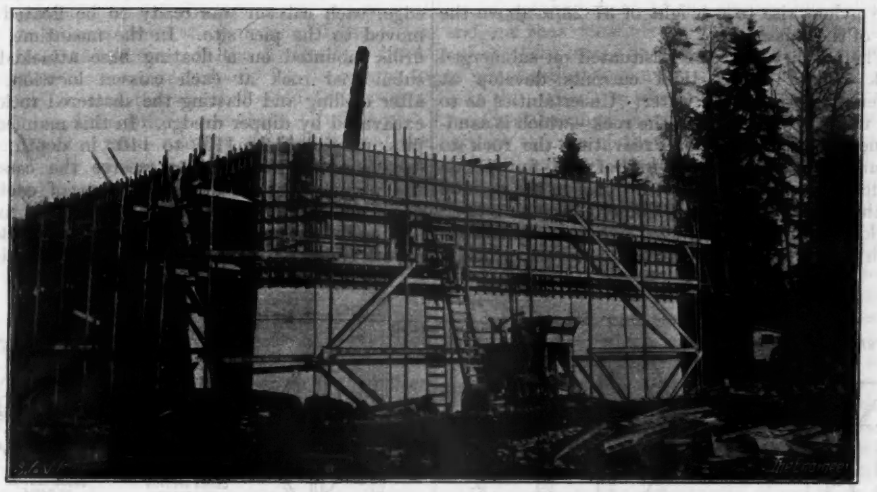
The main and the two side spans are suspended from two main cables, each of which has a length of approximately 3400ft. The cables are spaced 40ft. apart and each of them is composed of sixty-one separate strands. Each strand has a diameter of 1 7/16in. and contains forty-seven wires, most of which have a unit diameter of 0·196in. Each main cable has its strands arranged in nine tiers so as to form a hexagonal cross section, and the strands in alternate layers are of opposite lay. Oil-soaked fillers of cedar cover the hexagon so as to produce a circular cross section, and, so rounded, each cable was wrapped with a continuous serving of galvanised soft steel wire as a protection against the weather and the atmosphere. The outside diameter of the finished cable is 13¼in. The wire for the cables was furnished by John A. Roebling's Sons Company, Trenton, New Jersey, and the strands for the cables were produced by the Anglo-Canadian Wire Rope Company, at Rockfield, Que. The Dominion Bridge Company, Ltd., pre-stressed, marked, and socketed the strands at its Longueuil, Que., plant, and then wound them on wooden reels for shipping to the bridge site at Vancouver. The average strand load, as computed, was put at 105 kips; but during tests to destruction typical strands withstood a tension of at least 250 kips.

The suspenders are of the independent wire rope centre type and are made of the same wire that was used for the main cables, and they were also pre-stressed and socketed at Longueuil before shipment to Vancouver. Each suspender rope has a diameter of 1⅜in., and the two parts of each suspender are looped over a band on the main cable and secured separately at their lower ends to the top chord of the designated stiffening truss of the suspended span. The two parts of each suspender are cross tied transversely at regular intervals.

The stiffening trusses of the suspended span, which are of the Warren type, are 40ft. apart on centres, and each truss has a depth of 15ft. The

trusses, at their bottom chords, are tied together by cross beams, with intermediate diagonals and stringers. The deck of the span is formed of interconnected panels of tee-grid filled with concrete. The three-lane roadway of the span has a width of 29ft. 4in. between the steel kerbs, and along each flank of the roadway there is a sidewalk 4ft. wide. The sidewalks are of concrete-filled tee-grid that is lighter than the tee-grid used for the roadway. The roadway sheds water laterally to scuppers and drains arranged at the kerb lines, and provision has been made for electric cables of various sorts serving the bridge and connecting the north and the south shore communities.

The two main towers rise to a height of 365ft. above the tops of the pier pylons. The towers are of plate and angle construction, and each of the two legs of a tower is made up of a central rectangular or box-shaped core that is of constant cross section from bottom to top, and along each longitudinal side of that core there is a wing box, also rectangular in cross section, that diminishes in width and area from the base upward. The graduated width of the side boxes gives the tower legs a taper or batter from bottom to top. Within each tower leg, at regular intervals, the structure is stiffened by a succession of diaphragms. At the present time ladders are installed in each leg to afford access to all levels, and the interior is lighted electrically. Provision is made for the possible installation later of electric elevators in the legs if such should be found desirable. The legs of each tower are tied together by struts and diagonals and the arrangement is such that none of



NORTH ANCHORAGE UNDER CONSTRUCTION

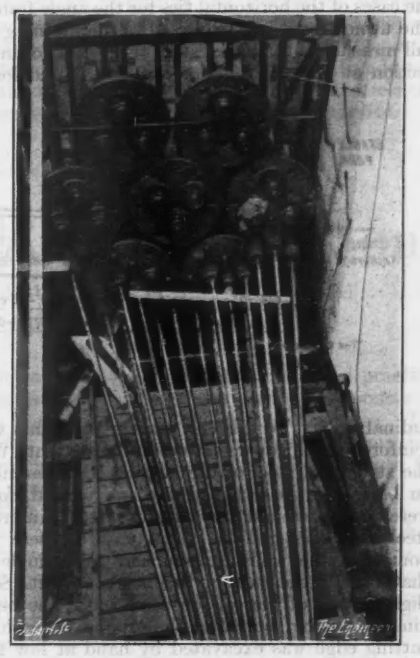
the lattice work of these members is visible from the ordinary plane of observation. Each tower leg has a flaring foot, which is riveted to a structural steel base, cruciform in plan, measuring 22ft. by 12ft. by 2ft. 6in., and weighing 18 tons at the time of placing. Each of the bases is anchored to the masonry of the pier by a system of large and long steel bolts that are embedded in the concrete of the two pylons that immediately support the legs of each tower. The towers have a transverse batter, the width at the base being about 70ft. and at the top 40ft. These structures were built throughout of carbon steel.

The trusses are not continuous at their passages through the towers. At those points provision has been made for longitudinal, lateral, and vertical movements by equipping the junctions there with floor expansion joints of the finger bar type, and at each tower there are three such units. The side units at each portal are fixed to each of the span sections meeting at the tower, while the central unit is placed so as to "float" between the two side units, special limiting features being provided to keep the floating unit centrally located. According to Mr. P. L. Pratley, of the firm of Monsarrat and Pratley, "The movement of the axis of the west truss, for instance, from the one extreme of no live load, low temperature, and east wind, to the other extreme of full normal live load, high temperature, and west wind, amounts to about 33·75in." This suggests something of the magnitude of the problem involved in designing a bridge of the selected type, for service under the range of conditions of possible occurrence at Vancouver.

Again, to quote from Mr. Pratley, "The shoes of the trusses are allowed to slide longitudinally in bronze-lined slots provided on the main supporting transverse strut and are also permitted, by suitable detail, to rotate slightly in the horizontal plane, thus accommodating themselves to the deflections caused by lateral wind load. Further, the short rocker posts which connect these shoes to the trusses have horizontal pins at both top and bottom, which arrangement permits trusses and rocker posts to rotate independently in the vertical plane. The south side suspension span is fixed longitudinally to the south abutment on its axis, but is given freedom to rotate in the horizontal plane by a vertical pin introduced in the connection at this point where the lateral system transmits its shear to the masonry. Freedom of rotation in the vertical plane, together with freedom of translation longitudinally, is provided at each truss shoe on the abutment by means of special bearings. Pins which pass through the gusset plates of the truss have square ends which slide in bronze guides on the pier members, the latter being composed of welded structural assemblies. The north side suspension span has similar multi-purpose bronze bearings in the webs of the tower legs at the intermediate tower, which is known as the north cable bent. This tower itself is flexible and subject to deflection at its top, due to the back stay stretch of cable changing length under the influence of live load and temperature. The first girder span of the north approach viaduct therefore has sliding bearings on the cross supporting strut which forms part of this tower, and another elaborate floor expansion detail is introduced to accommodate all these possible movements."

The two anchorages, north and south, for the main cables are gravity type reinforced concrete structures, in which the steel features for the cable connections are identical for both, but the massive concrete anchorages differ in each case because of the physical circumstances of their situations. The south anchorage is virtually embedded in the ground, except that the top surface of the monolith is at the roadway level, while the base at the rear of the anchorage is about 45ft. deeper. The formation in which the anchorage is set is a dense deposit of glacial till, and it was found so firm that the site was excavated to the prescribed maximum depth without recourse to any shoring. The north anchorage, on the other hand, rises from low ground that is composed of sand and coarse gravel. Most of that anchorage is exposed for a height of 40ft. above ground, and the deepest part of the foundation section is about 30ft. underground and below water level. The north anchorage was built upon a reinforced concrete caisson that had a length of 78ft., a width of 30ft., and a depth of 30ft. The caisson was sunk by open dredging. Above ground the north anchorage was given an architectural treatment that, because of its prominence, would make it harmonise with the other substructure features of the crossing.

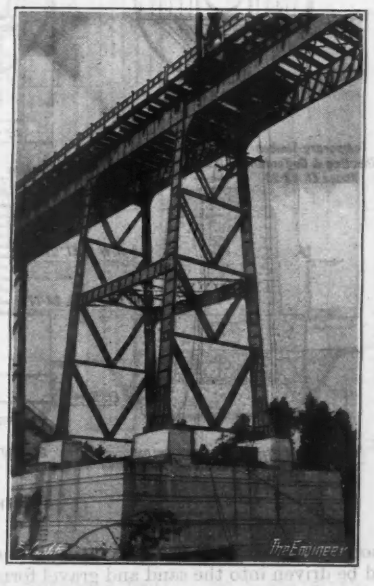
The fundamental feature of each anchorage is a splayed assembly of heavy forged rods that was erected on structural steel frames at the end of each cable, and after the cable strands were secured to the steel work the latter was permanently embedded in massive concrete. The splayed rods projected toward the cable ends through distributor buttons, and at their outer ends the rods were threaded. Each one of these steel buttons was formed of a circular plate 3ft. 6in. in diameter and 5¼in. thick, and the plate was machined on its face to a plane surface, while the rear surface was given a convex form. Each button was pierced by a number of holes through which the anchor rods could be passed from the rear, while the socket bolts for the cable strands could be passed from front to rear through holes provided for them, the nuts for the two sets of bolts being seated from opposite sides of the distributor button, in each case. For each of the four anchorage units, or the four ends of the two cables, there was provided an assembly of seven buttons, on the front face of which were adjusted the nuts of twenty-one anchor rods and on the rear convex face there were



CABLE STRANDS AT ANCHORAGE

arranged the nuts of sixty-one strand socket bolts. The threading of the bolts permitted slight adjustments to be made so as to neutralise any field inaccuracies or other small irregularities, thus finally distributing evenly the proper measure of stress on each cable strand.

Because of geological and other controlling conditions at the site of each of the piers for the two main towers of the suspended span, the caisson work for each pier was different from that carried out at the other one. In some respects the sinking



VIADUCT TOWER OVER NORTH ANCHORAGE

of the caissons for these piers was the most interesting of the various operations and required considerable time in preparation and in carrying the jobs onward to completion. The pier for the north tower rests upon a single caisson, while the south pier is founded on two caissons which were sunk independently. The north caisson, which penetrated a formation of sand and gravel at a situation which is bared at low water, has its cutting edge landed at a depth of substantially 78ft. below the level of high water. That reinforced concrete structure was built with an overall length of 117ft. and an outside width of 47ft. 10in. The two long

parallel sides had a length of 89ft. 5in., and the two blunt-pointed ends projected in each case 13ft. 9½in. Internally, the caisson was subdivided by the longitudinal and the transverse interior walls into twelve compartments or dredging wells. The structural steel of the cutting edge of the outer walls of this caisson reached to a height of 5ft. 6in. above the base line at the outer surface of the caisson, and the cutting edges of the cross walls, also armoured with structural steel, had their base lines 2ft. higher than the main cutting edge. Steel work of the cutting edges was welded throughout except for the riveting used in the cases of the horizontal ties for the angle frames. The utmost care was exercised in maintaining the full measure of fortifying steel at all areas of intersection at the junctions of cross walls and longitudinal walls. To this end corners and joints were reinforced with cover plates of ample extent. With the structural steel of the cutting edge assembled on blocks at the assigned site and welded, forms were reared around the cutting edge, reinforcing steel was arranged in place, and concrete was poured in the walls continuously in a single lift that brought the walls up to a height of 7½ft. Some slight listing of the caisson occurred at the beginning of sinking, but after the ground beneath the cutting edge was excavated by hand at low tide, from within the caisson, the structure was restored to level and its further progress downward proceeded without any untoward development.

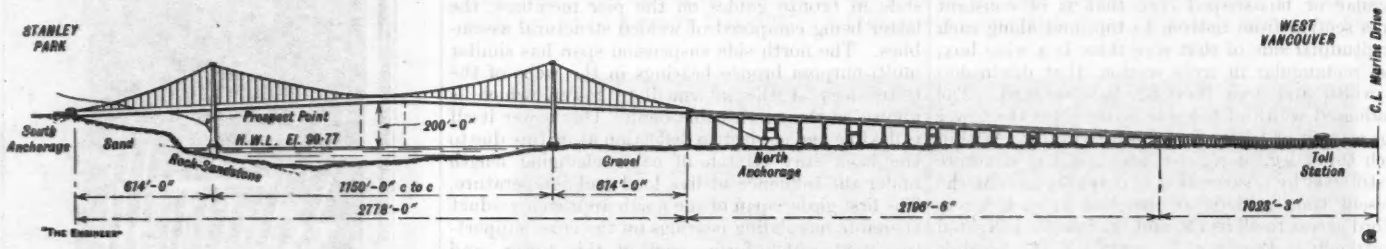
Two orange peel buckets, handled by two derricks mounted on pile clusters at opposite sides of the caisson, were used to do the excavating. The piles could be driven into the sand and gravel formation less than 20ft. and in ground that tended to move inward toward the cutting edge as dredging progressed, and that state of affairs occasioned doubt as to whether the working platforms for the derricks could be maintained at the prescribed elevation. This situation was controlled by having men on watch at each platform, and any subsidence of the pile clusters, which at no time was of considerable moment, was promptly corrected with the aid of jacks and blocking. Small charges of dynamite in the different dredging wells, under water, were used wellnigh daily to assist in breaking up the formation and to promote the sinking of the caisson. The caisson, by working night and day, was brought to rest at a level of a trifle less than 77·5ft. below maximum high water in the course of a little more than three months.

With the cofferdam down, the eight end wells were backfilled with sand and gravel to a height of 17ft., and the four central wells were similarly backfilled to a height of about 49ft. Next, the eight end wells were sealed with a layer of tremie-poured concrete, 14½ft. in thickness, and the sand and gravel backfill in the four central wells were sealed with plugs of tremie concrete, 5ft. thick. After all twelve of the foregoing seals had set the caisson was unwatered. Further operations were carried on in the dry within the surrounding temporary timber cofferdam that rose to a safe height above maximum high water. Dry concrete was placed in all the wells of the cofferdam, and this work was finished with a sealing top slab 6ft. thick, that brought the concrete backfilling up to a level of 60·25ft. above the cutting edge. The two surmounting granite-faced concrete pylons were then constructed within the temporary cofferdam. The pylons rise to a height of 37·25ft. above the top of the caisson.

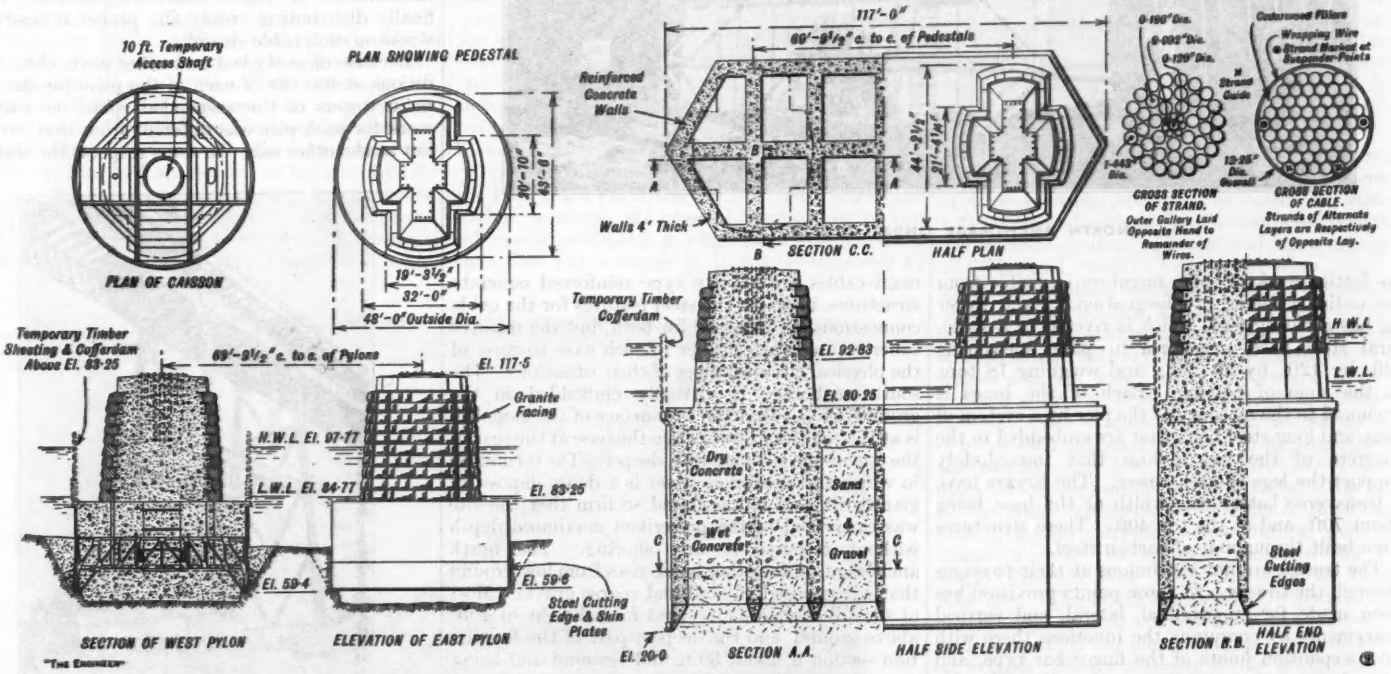
The south tower pier is situated on submerged rock, where strong tidal currents develop at different stages of the water. Uncertainties as to the uniform soundness of the rock—which is sandstone—and the need of excavating the rock to assure a satisfactory keying of the foundation structure, introduced problems that in the opinion of the contractors, Stuart Cameron and Co., Ltd., could best be dealt with by sinking a caisson for each pier pylon, and placing the caissons on an east-and-west line with their centres 69ft. 9½in. apart. As far as practicable the plan was to sink these caissons by open dredging in order to keep the cost of the work down. But each caisson was designed to be operated under compressed air if that should be found at any stage of sinking to be necessary in getting one or both of the caissons properly seated and bonded with the bedrock. In other words, the caissons were made convertible to meet either method of sinking, and for that reason were somewhat novel.

The caissons were constructed on the water front near the south pier site, and when ready they were floated and moved to their assigned permanent positions. Each caisson was cylindrical in form and 48ft. in outside diameter. The cutting edge, in each case, was made of structural steel and had a height of 6½ft. The cutting edge was surmounted by four steel trusses, 8½ft. in depth, arranged in two pairs forming a rectangular cross about a 10ft. steel shaft which was placed in the centre of the caisson and extended from the working chamber roof upward, providing an access shaft either for open dredging or working under compressed air. In the latter case, the shaft could be fitted with an air lock at the top. The four trusses were stiffened horizontally and tied together by a succession of paralleling I beams which were secured to the bottom chords of the trusses, and that grid also served as the reinforcing of the concrete roof of the working chamber. From the top of the cutting edge upward for about 17ft., the cylindrical shell was formed of permanent sheeting and suitably stiffened circumferentially by a wale of laminated timber placed near the top of the sheeting. So constructed, and with a layer of concrete in the working chamber roof and some concrete in the lower part of the cutting edge, each caisson was ready to be floated and moved to the pier site. In the meantime, rock drills mounted on a floating base attacked the submerged rock at each caisson location, and after drilling and blasting the shattered rock was excavated by dipper dredge. In this manner two pits, ranging from 11ft. to 14ft. in depth, were excavated in the rock to receive the caissons, the peripheral rock at the bottom of each pit being levelled by divers to provide the initial seating for the cutting edge of the caisson. Before actual sinking was started on a located caisson, the permanent sheeting shell was stiffened within by the pouring of a contiguous wall of concrete 1ft. thick; a heavier wall of concrete was placed around the central steel shaft, and more concrete was poured into the cutting edge and above the roof of the working chamber. A temporary cofferdam, built of timber sheeting, was added at the top of each caisson so as to extend its effective height about 19ft., and two valves were placed inside the structure so that the cofferdam could be flooded sufficiently to give the caisson ample dead weight to hold it, when grounded on the rock, in its assigned position, notwithstanding the sweep of strong currents which, so it is reported, at times exceeded a velocity of 6 knots.

The contractor had planned from the first to




GENERAL ELEVATION OF LIONS GATE BRIDGE AND VIADUCT




SOUTH AND NORTH MAIN PIER CAISSONS AND CROSS SECTIONS OF CABLES

surround the cutting edge of each caisson, after seating, with an envelope of tremie-poured concrete to bond the structure with the rock and to seal it so that it could be unwatered and further dredging done under atmospheric conditions. Compressed air was to be used in completing the work only if the underlying rock contained water-bearing seams that could not be held under control by pumping. In the latter case, the work was to go forward by the pneumatic method for which the caissons were made adaptable. To do the originally contemplated sealing of the cutting edge the projected work called for the erection, on the water bed throughout the offshore arc of each caisson site, of a wall formed of concrete blocks, measuring 6ft. by 3ft. by 3ft., so as to confine the tremie concrete within the desired bounds and to give it a maximum thickness of about 5ft. This was done as planned in dealing with the east caisson, which was the first to be seated and its unwatering attempted. Close to and around the outside of the cutting edge, in the freshly poured concrete, were set up 2in. grout pipes at 4ft. intervals. Before the pouring of the tremie concrete, divers placed bags of sand against the inner side of the cutting edge to arrest any inflow of the concrete. Sufficient time was allowed for the setting of the concrete, and then pumping was started to unwater the caisson preparatory to beginning excavation from within the caisson by the open-dredging method.

It was at this stage that the contractor encountered a setback that appeared to threaten a serious upset to his plans. A layer of sand, which should have been removed by the divers, had been left on the bedrock and the tremie seal was laid on that unstable material which promptly was washed into the caisson when the pumping of the latter caused an unbalancing of the hydrostatic head. The inflow increased too rapidly for the pumps to overcome it, and the water flooded the working chamber and the 10ft. access shaft. Undismayed, the contractor made another attempt to seal the cutting edge of the east caisson by pouring a second and more expansive tremie seal throughout the arc of the troublesome area. The confining barrier was made up largely of gravel-filled boxes and tapered off with a line of sand bags. Again, grout pipes were set up in the still plastic concrete and forced down to the rock surface. Shortly afterwards, when the supplemental seal had set, the grout pipes were drilled clear and the drill steels driven into the underlying rock. The seal and the grouting were effective, and thereafter only a small leakage persisted which was easily kept under control.

After the east caisson was satisfactorily sealed then an annular trench, 2ft. wide and approximately 4ft. deep, was excavated with paving breakers just within the cutting edge, and a cut-off wall of concrete was poured into the trench to serve as a covering for the rock to prevent spalling and to stop all leakage, the top of the wall extending some inches above the cutting edge. The rock enveloped by the cut-off wall and to the depth of that wall was then drilled and excavated to produce a circular keyway into which was poured in the dry the final bottom seal of the caisson and the anchoring bond to the rock. With that done, the entire interior of the caisson was filled with concrete, thus forming a monolithic substructure on which to rear one of the two pylons of the south tower pier.

Work on the substructures was started in April, 1937, by Stuart Cameron and Co., Ltd., the attack being simultaneously at five points—that is, at the south anchorage, the south main pier, the north main pier, the north anchorage, and the north viaduct pedestals and abutment. Because of the varied nature of the different tasks, visible signs of advance were not marked in some instances, but even so the contractors for the structural steel, the associated organisations of the Dominion Bridge Company, Ltd., and the Hamilton Bridge Company, Ltd., were able to do work at the two anchorages and to commence the erection of the steel for the approach viaduct on the north shore. From that time onward progress was consistently rapid.

The approach viaduct was built of steel only after structures either partly or wholly of concrete had been carefully considered. Steel was found to have decided advantages. The structure consists of a succession of plate girder spans carried on a series of towers or bents. The spans were laid out so as to permit extensive repetition of deck, fence, and tower details. The maximum open span is 123ft. There are two such spans at the high end of the viaduct, and each girder weighed 28 tons. The cross beams are spaced uniformly 44ft., are laid upon the top flanges of the girders, and are cantilevered a few feet beyond on each side to support the sidewalks and the fences. At four points throughout its length the viaduct is supported by four rigid-frame towers, which, in effect, divide the viaduct into five sections for expansion, the towers offering strong resistance to any longitudinal deflections. For all practical purposes the legs of the several towers or bents are virtually vertical plate girders. They have a uniform batter to their webs and are flared at the bottom so as to subscribe to a uniform design for the sake of appearance. The deck on the viaduct is of a conventional reinforced concrete type with open scuppers and with manholes at conveniently frequent intervals to afford access to power cables, telephone lines, and inspection facilities. The Lions Gate bridge is equipped with observation platforms outside the trusses; it has a signal control bridge and marine signalling station at the centre of the main span, and there are permanent movable inspection bridges provided beneath each of the three suspension spans. There is an aviation beacon at the top of each tower, and the bridge, the north viaduct, and the approach roadway from the south are all illuminated after nightfall by sodium vapour lamps.

The owners of the structure are the First Narrows Bridge Company, Ltd. The Right Honourable Lord Southborough, G.C.B., G.C.M.G., and Alfred J. T. Taylor are respectively the chairman and the president of that organisation. The bridge was designed by Monsarrat and Pratley, of Montreal, in association with Mr. W. G. Swan, of Vancouver. Robinson and Steinman, of New York City, were engaged by the owners as consultants. In addition to the illustrations accompanying this article two views of the bridge will be found on page 544.

# Industries In and Around London

By JOHN HOLLOWAY

## No. VII—PNEUMATIC POWER TOOLS AND MACHINES

THERE are many engineers living to-day who will remember the introduction of pneumatic power tools and machines into this country, and though hardly more than thirty-five years have passed since pneumatic tools were first brought over from America, their manufacture has become, an important branch of the engineering industry, and one that demands the best quality steel from our steel makers, and gives constant employment to many skilled workmen.

In the early days, when the makers of pneumatic tools were having difficulty in overcoming prejudice against the use of the new tools, London became, and still remains, the centre of one firm which has always been solely engaged in the pneumatic power industry, for in February 1905, one of the pioneers in the development of pneumatic tools—Mr. J. W. Tierney—established the Globe Pneumatic Engineering Company with headquarters at 1 Victoria Street, S.W.1 and works at Chadwell Heath, and they are still in business at these addresses, which is some indication of their stability. It would seem to have required some courage to start this new business, for as everyone knows, the fate of pioneers in any branch of industry has not always been exactly pleasant, and the remembrance of the dire straits to which some have been reduced, engineers among them, adds pleasure to the opportunity of recording that in this instance, at any rate, the pioneer has fared better, having lived to see his efforts succeed, for the Globe Pneumatic Company, of which he is still Chairman and Managing Director, was founded and operated on the improved pneumatic tools and machines Mr. Tierney had patented in Britain and foreign countries.

### EARLY HISTORY OF PNEUMATIC TOOLS.

But even in this instance a few obstacles were encountered on the way up, and some engineers may recall a law action in which this firm was involved, as defendants, on the question of infringement of patents. The firm finally obtained a favourable decision, but not until the case had been heard and settled in the House of Lords by Lord Loreburn and five other learned lords. All that is now somewhat ancient history, and the contestants have long since become very good business friends. But quite apart from the merits of the case, there was one important feature that is of interest to all engineers and to inventors generally, for during the hearing of the case a careful search was made through the files of the Patent Office, and among the hundreds of specifications that were examined, two were found that appeared to have a direct bearing on the case, and in order to clarify the matter, scale models of the inventions were made in strict accordance with the description given in the specifications. A major object in making these models was to ascertain beyond the shadow of doubt if the inventions were practical and workable, or if they were only, after all, just a creation of an inventor's imagination that in practice had no real value at all. It is on record that these scale models did actually work, and could be operated with compressed air; there was no question of efficiency, the only point was—would they work? The record states that these models were taken to the House of Lords and a practical demonstration given there during the course of the hearing to prove the defendants' case. The models were actuated by compressed air supplied from charged air bottles taken to the House for the purpose.

Thus was it established that the principle on which pneumatic hammers operate to-day, had been conceived as far back as 1867 and means of employing it disclosed in the specifications already mentioned. The first was known as Doering's Rock drill, patented in 1867, and the second was Brazelle's steam pump, patented in 1883.

Both these models are preserved as interesting

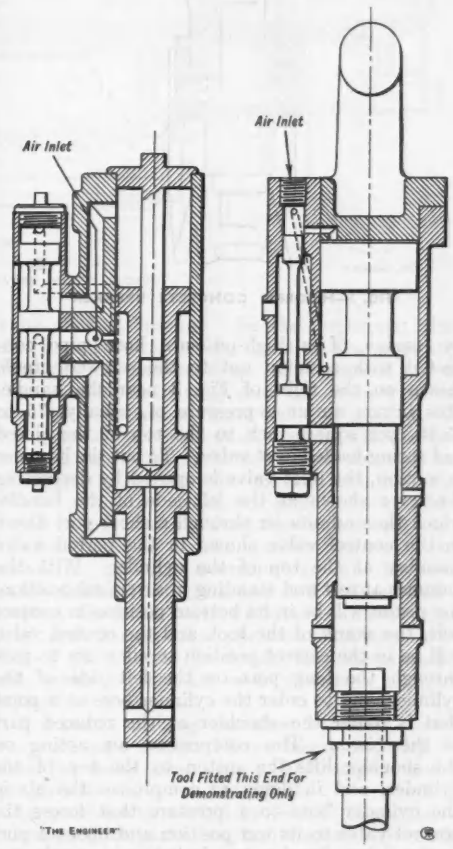



FIG. 1—DOERING'S DRILL FIG. 2—BRAZELLE'S DRILL

relics in the showroom at the Globe Company's works at Chadwell Heath. A sectional drawing of Doering's Rock drill is given in Fig. 1 and a similar drawing of Brazelle's steam pump in Fig. 2. The tool shown in Brazelle's pump was fitted there for the purpose of the demonstrations only.

These models, and particularly Doering's Rock Drill, may be taken as the genesis of the modern pneumatic hammer and rock drill, as in both the old and the new machines the control valve is not mechanically connected to the piston, but is actuated by fluid pressure which is controlled by the movement of the piston, both the valve and

the piston being interdependent for their movement.

### MODERN PNEUMATIC TOOLS.

While there has been but little change in principle during the development of pneumatic tools and rock drills, a great advance has been made in general design and efficiency, and also in the material used in construction. As a striking comparison between the old and the new, a sectional view of a modern pneumatic hammer, used for concrete breaking is given in Fig. 3, this being the Globe heavy-type concrete breaker.

All pneumatic hammers of both heavy and light type work on much the same principle, and any difference in design that may be found among the various makers affects mainly the details. The cycle of operation is now generally understood, but for the benefit of readers who have not had occasion to deal with them, a short description may be useful. Compressed air is delivered to the hammer

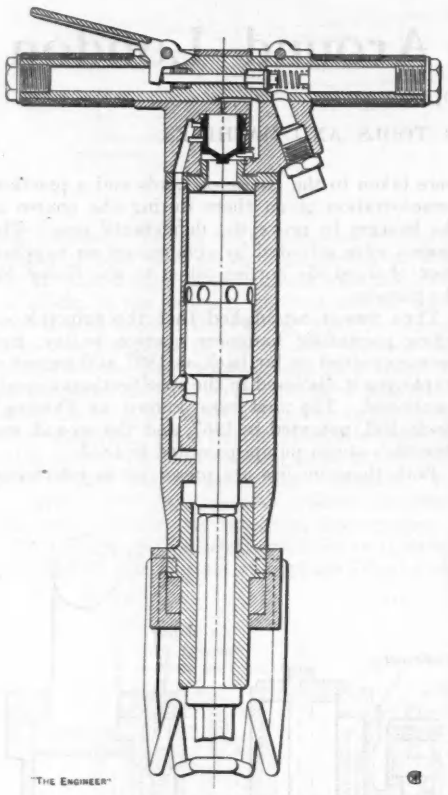



FIG. 3—MODERN CONCRETE BREAKER

by means of a high-pressure hose pipe connected with a union nut to the screwed nipple shown on the right of Fig. 3 near the handle. This brings air at a pressure of, usually, 75 to 85 lb. per square inch to the top of the closed and spring-loaded inlet valve. To put the hammer in motion, the inlet valve is opened by depressing the lever shown at the left side of the handle, which then admits air through a short port direct to the control valve shown in the ported valve chamber at the top of the cylinder. With the hammer at rest and standing in a vertical position, the piston will be in its bottom position in contact with the shank of the tool, and the control valve will be in the correct position to allow air to pass through the long port on the left side of the cylinder, and to enter the cylinder bore at a point that is under the shoulder at the reduced part of the piston. The compressed air acting on the shoulder lifts the piston to the top of the cylinder, and in doing so compresses the air in the cylinder bore to a pressure that forces the control valve to its top position and opens a port in the valve chamber to admit live air to the top of the piston. Meanwhile on its upward stroke the shoulder of the piston has moved beyond the exhaust port-holes shown near the middle of the cylinder, and the air that has done work in lifting the piston escapes to atmosphere, leaving the piston free to descend, without being cushioned, and to strike the shank of the tool. It will be noticed that on its downward stroke the top of the piston has again uncovered the centre port holes, and allowed the air to exhaust to atmosphere, and as the pressure is released from the underside of the control valve it is forced down again by air pressure admitted to the top through the small centre hole shown in the figure. With the control valve in its lowest position, the port is again open to pass live air to the underside of the piston and lift it to the top of the cylinder. This cycle of operations is repeated approximately 1200 times per minute, a blow on the tool being struck at each down stroke of the piston.

It has been seen in the foregoing that to lift the piston to the top of the cylinder, air is admitted to the underside of the piston, and this necessitates some means being provided to prevent air leakage taking place at the bottom and open end of the cylinder where the shank of the tool enters to take the blow from the piston on its down stroke. Some makers of these heavy type hammers insert a close-fitting anvil that rests on the tool shank at the bottom of the cylinder, and depend on the close fit of the anvil to prevent serious air leakage. But, in the Globe hammer the anvil is dispensed with and leakage of air prevented by reducing the bottom end of the piston to a length that is greater than its travel, and as this reduced part is made the same class of fit in the lower cylinder bore as in the upper bore, air leakage round the tool shank is effectively prevented. This method is clearly shown in Fig. 3.

In smaller size hammers used for chipping, caulking, and riveting, there is less difficulty in making the shank of the tool a close fit in the bottom of the cylinder and the bore is made to one diameter only throughout the length of the piston stroke, and the anvil can also be dispensed with. In some types of Globe hammers a hardened bush is fitted to the tool end of the cylinder, and the bore of the bush is made a good fit to the shank of the tool; the bush can be renewed if at any time it is found desirable. These hammers are made in a number of sizes and weights, ranging from 0·8in. bore×1⅝in. stroke and 8 lb. in weight, to 1¾in. bore×8½in. stroke and 26 lb. in weight; the small size being used for light chipping, caulking, riveting, and light stone work, and the large size for dealing with snap head rivets up to 1⅝in. dia. and countersunk headed up to 1¼in. dia.

### TESTING PNEUMATIC TOOLS

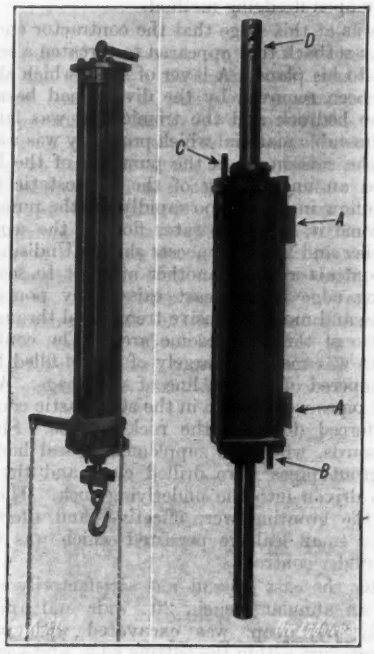
Testing the power, or weight of blow, delivered by pneumatic hammers has never been put on a scientific basis, for the simple reason that at present no scientific or standardised method of testing exists. Quantity of air used per minute can be and often is checked with an air-flow meter, and the irritating noise they make has been measured—by comparison—at the National Physical Laboratory, but no exact method of measuring the amount of work done per cubic foot of air consumed has been devised, so that users generally have to be content with a rough and ready comparative test when examining the claims of various makers, and this, unless proper precautions are taken, can be quite misleading. The quantity of air at any given pressure that is used in operating a hammer is no criterion of the useful work done, for there are several factors that go to make a pneumatic tool either effective or ineffective, efficient or inefficient. For instance, unless the air used to lift the hammer piston on its up stroke is quickly and totally exhausted, and the exhaust ports kept full open during the down stroke of the hammer piston, it will be cushioned on the air remaining in the cylinder and the blow on the tool softened in direct proportion to the ratio of cushion. Naturally, in such conditions much less useful work will be done. That is why the use of silencers on the exhaust of pneumatic hammers is disliked, but in any case the noise of the air exhaust is but a fraction of the noise made by the piston hitting the tool, and the tool pummelling the object on which it works, be it a rivet or hard concrete.

Another factor affecting the efficiency of these tools—measured in terms of useful work done—has relation to the human factor, and is largely dependent on the operator, because, as is generally known, any pneumatic tool of standard type has to be firmly held up to its work by the operator to get the best result out of it, and unless it is so held, very little, if any, really effective work will be done, for the very good reason that the reaction or back kick of the hammer body is sufficiently severe to force the hammer away from the shank of the tool on which the piston should do its work. That is the real reason why no attempt is made to make pneumatic tools particularly light in weight, for the lighter the hammer the more weight must the operator add to hold it up to its work. This is a feature that is common to all standard type pneumatic tools.

Heavy pneumatic road drills or concrete breakers are usually judged for efficiency on the amount of concrete they will break up in a given time, that being the question with which the road contractor is most closely concerned, and no wonder, for after all he has to estimate the cost of breaking up the old concrete in the road before the new bed can be laid, and what he wants to know with as much certainty as possible is how many cubic yards of concrete a man with a pneumatic drill can break up in a normal day's work, and that means for a normal day's pay. Naturally the contractor wants to be assured that the tool he buys will stand up to the rough usage it will always get in this class of work, and that the repair bill will not be so high as to consume a reasonable margin of the profit.

But even after tool reliability, freedom from undue wear, and frequent breakdown have been guaranteed, the capacity test on concrete still remains unsatisfactory because of the wide variation in hardness that is met with, and for this reason the Globe Pneumatic Engineering Company uses a method of testing pneumatic hammers that eliminates some uncertain factors and gives a truer indication of actual work done for a given expenditure of compressed air power than is generally attained with more rough and ready methods.

For this test a semi-steel casting approximately 14in. square×16in. deep, bored with a 2in. dia.




FIGS. 4 AND 5—AIR HOIST AND DOOR OPENER

hole at the centre from the top face to a depth of 6¼in. is used. In the hole is inserted a hardened steel plug that rests on the bottom face of the hole and extends to within 4in. of the top face of the casting. To make a test, a piece of steel is placed in the hole with its lower face resting on the hardened plug and a special flat-ended tool is fitted to the hammer. The flat-end of the tool is placed in contact with the top face of the specimen, and the hammer is then run for a period of 10 seconds. Then the specimen is taken out of the block and measured to ascertain the amount its length has been reduced in the hammering process. Great care is taken in preparing the pieces of steel for the test. They are cut off rolled-steel bars and the ends truly faced to micrometer length. Each piece is brinelled and only those that agree with a uniform hardness are used. With these conditions faithfully observed it is possible to obtain a true comparison of the effective work done with any number or type of pneumatic tool, and to prove beyond doubt that the tool is working efficiently or otherwise. During these tests at the Globe works, an air-flow meter is always used to check the air consumption, and during a test carried out on the lines indicated, and witnessed by the author, the air consumption for operating a heavy road drill, similar to the one shown in Fig. 3, was 50 cubic feet of free air per minute, the air pressure being 75 lb. per square inch gauge.

It will be appreciated by all users of pneumatic hammers, how valuable a test of this nature can be, for once a standard has been set up for the crushing effect of a new tool on a standardised specimen of steel, hammers that are in practically constant use can be checked up periodically, and the impaired efficiency—if any—quickly dis-

covered. Care must, of course, be exercised to ensure that all the test specimens of steel are alike in length, diameter, and hardness, and it is always advisable to check the hardness on a standard hardness testing machine. A test of this nature is, perhaps, particularly valuable in the case of overhauled and repaired tools, as it will show at once if the repair has been satisfactorily carried out, and in periodic test to show when a overhaul is necessary. It should always be remembered in connection with pneumatic power, that while air as air is cheap enough, it costs something to compress it, and leakage is extravagant waste.

### PNEUMATIC LIFTING APPLIANCES

Pneumatic power is being extensively used for lifting appliances and because of its reliability and low maintenance cost of the apparatus it is rapidly gaining in favour. A variety of straight lift pneumatic hoists are made by the Globe Pneumatic Company, and these cover a wide range in size and power. The largest size made is usually limited to 12in. diameter bore with a lift of 7ft. and a load capacity of 4 tons when operating with an air pressure of 85 lb. per square inch. These straight lift hoists are particularly simple and robust in construction, all the essential parts being made in mild steel. The cylinders consist of selected solid cold-drawn steel tube; the tube is straightened and the ends are faced to receive the top and bottom covers, and the bore is prepared

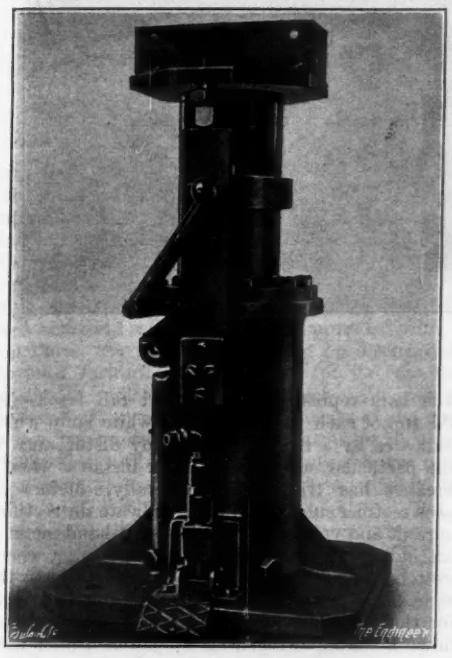


FIG. 6—PNEUMATIC JACK

for the piston and packing by a lapping process. The end covers are made from rolled mild steel plate, but in some sizes, where the numbers are large, the covers are made from mild steel blanks. Both the end covers are secured to the cylinder tube by four long bolts of square section that stretch from end to end, the ends that pass through the covers being turned and screwed for retaining nuts; the tube is, therefore, in no way weakened by screwing, or distorted by welding on end flanges.

A typical Globe straight lift balanced pressure hoist, constructed as described above, is shown in Fig. 4. It has a 4ft. lift with a 5in. cylinder bore. It is suspended by a mild steel eye bolt, and the bottom hook has an all-round swivel action which is made easy by the load being taken on a totally enclosed Timkin ball bearing. In this case the control valve is fitted at the bottom of the cylinder and is operated by chains attached to a self-centering cross lever, but where found desirable the control valve can be fitted to the top of the cylinder, and operated with a push-pull rod attached to a single ended lever. When in use, these balanced pressure hoists have compressed air at full pressure acting continuously on the underside of the piston, and the lower part of the cylinder is never open to atmosphere; this ensures smooth action when lowering or hoisting the load, and also economises in consumption of air. The control valve is of the rotating disc type, and is ported to admit air to both the top and bottom of the cylinder, but to exhaust the air from the top only. In operation the action is simple and direct. The handles on the chains attached to the cross lever of the control valve are marked "Raise" and "Lower." When the one marked "Raise" is pulled, the valve is rotated and allows the air to be exhausted from the top of the piston while air at full pressure flows in at the underside and hoists the load. To stop, the chain is released and the valve goes back to neutral position, leaving the load held steady by the air pressure under the piston. To lower the load it is only necessary to pull the chain marked "Lower," and the valve is rotated in the opposite direction, allowing air at pressure to flow in at the top side of the piston, and by reason of the area of the top side of the piston being greater than the bottom side, the difference being equal to the cross-sectional area of the rod attached to the underside of the piston, the piston is forced down and the air in the lower part of the cylinder flows back into the air main, while the load is lowered. On the chain being again released, the control valve goes back to its neutral position and the lowering action ceases. There is always full control in the action of hoisting or lowering; stopping and starting in either direction is practically instantaneous, and inching or creeping, so valuable a feature in placing a load just where it is wanted, is accomplished without undue wear and tear on the operative parts.

A further safeguard is provided on these hoists against the sudden falling of the load if the air supply should fail from any cause whatever. A safety check valve is fitted at the air inlet point and prevents the compressed air escaping from the cylinder if the air supply fails. There is also a wide margin of safety in all parts taking the load, and it is the practice of the firm to test every hoist to 100 per cent. overload before being despatched. A careful log is kept of all tests taken, and the certificate of test sent with each hoist is signed by the qualified engineer who has witnessed the test.

Pneumatic cylinder hoists are now used for a great variety of purposes. They are to be found operating in many foundries and machine shops, their immunity to the effects of fumes or dust in foundries making them especially useful and adaptable for work therein. In machine shops employed on medium heavy work that cannot conveniently be man-handled, the hoists are suspended from the carriage of a runway over the machine, and the work pieces moved on and off the machine with ease and dispatch.

In cases where the head room is limited, short cylinder hoists fitted with double purchase tackle are employed. These will lift to a height approximately double the working length of the cylinder while the lifting capacity in weight will be halved.

Another type of air cylinder used for lifting purposes is shown in Fig. 5. This type is used for opening furnace doors and may be placed in any convenient position for that purpose. The cylinder is fixed in a vertical position by the side brackets AA, and a wire rope attached to the furnace door is led over pulleys to the hollow piston rod, which projects through each end of the air cylinder. The wire rope is passed through the piston rod and made secure by means of the holes shown at D, while weights are attached to the bottom end of the wire to counterbalance the weight of the furnace door. Air enters the top and bottom of the cylinder at C and B, from a control valve arranged to be foot-operated. Should the air supply fail, the wire rope can be quickly detached from the piston rod, and the furnace door opened by pulling on the balance weight end of the rope.

A pneumatic jack, designed and constructed by the firm is shown in Fig. 6. The jack works in conjunction with a heavy heading and shearing machine, and its function is to raise and lower a heavy bar, heated for forging purposes, to a level suitable for the first operation of heading, and then to a height for the shearing operation. The quicker the heated bar can be handled the greater will be the number of heading and shearing operations that can be carried out at each heat, and the quick movement of the pneumatic jack ram is well suited to save time in handling and moving the bar to the correct operative positions. As will be seen in the figure, the control valve is placed at the base of the machine, and is worked from the foot-rest shown. Specially designed stops are arranged on the jack to bring the ram to rest at the high and low positions.

### DRUM TYPE WIRE ROPE HOISTS

For high lifts, the drum type pneumatic hoist becomes necessary, and the Globe Company, along with its other activities, has specialised in this class of machine during the last 30 years. The latest design is shown in Fig. 7. The machine is operated by four air cylinders staggered radially round the crank. Each piston has its own connecting rod separately mounted with Hoffmann roller bearings on the crankpin, and the crankshaft

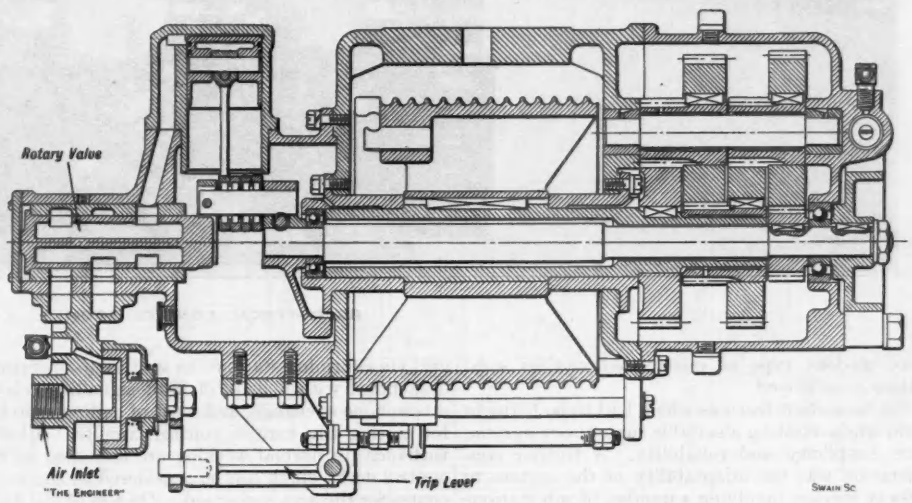



FIG. 7—PNEUMATIC WIRE ROPE HOIST

runs on ball bearings. In the larger size, from 2 ton and upwards, the drum is also separately mounted on ball bearings. The pistons are die cast in aluminium alloy and the connecting rods are steel stampings, hardened and ground. All the gears are of nickel steel, machine cut and heat treated, run in an oil bath, and are mounted in a dust-proof gear box To prevent the wire rope climbing on the drum, a special rope guide is fitted which travels along the drum and automatically cuts off the air by actuating the control valve to prevent overrunning. An improved safety brake is attached, and it is claimed that it renders the hoist perfectly safe when carrying a load, even though the compressed air supply should fail or the pipeline be accidentally disconnected. All working parts are well protected, and will withstand exposure.

Pneumatic drilling machines covering a wide range of sizes are, and have been, made by the firm for many years past. The largest size is adapted to take a 3in. twist drill.

In addition to a rigid system of inspection of all component parts, the firm consistently carries out tests on all machines before they are allowed to leave the works, thus reducing to a minimum all risk of complaint from the users.

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UNREMUNERATIVE RAILWAYS IN INDIA.—It is stated in the *Railway Gazette* that of the ten branch line railways whose revenues have been adversely affected by road competition, the Railway Board has come to a tentative decision that four of these, namely, the Rohatk-Gohana-Panipat, in the Punjab, and the Madura-Bodinayakanur, Salem-Mettur dam, and Vriddhachalam-Cuddalore lines, in Madras, are not to close down. The question of the other six lines, namely, the Kangra Valley, Lyallpur-Jaranwala, Coconada-Kotipalli, Tirupattur-Krishnagiri, Morappur-Hosur, and Shoranur-Nilambur branches, is still under examination.

# Remote Supervisory Control

No. IV

(*Continued from page 515, Nov. 24th*)

NO better example of supervisory control can be found than that on the Southern Railway which has now electrified 702 route and 1764 track miles of its system. As the manual control of all the sub-stations is undesirable, a system of centralised control has been adopted for the unattended mercury arc rectifier sub-stations, track paralleling huts, and E.H.T. supply points. On the suburban lines electrified prior to 1930, manually-controlled rotary converter sub-stations are still in use, but on other electrified lines the more modern type of unattended rectifier sub-station is employed.

The important features which had to be borne in mind when selecting a suitable supervisory system, were simplicity and reliability. A further consideration was the adaptability of the system to railway service, involving a number of sub-stations along a main line connected on a ring main and capable of performing a large number of operations with instantaneous effect. It was also necessary to take into account the possibility of extension with a minimum addition of pilot cable. All these requirements have been fulfilled by the system of control installed by the ASEA Electric Company, to the specifications of Mr. Alfred Raworth, the railway company's Chief Electrical Engineer.

The rectifier and transformer sub-stations are supervised in groups from five separate control rooms. Power for the main lines is taken from the 33-kV grid system at certain grid transforming stations. It is then distributed to the various rectifier sub-stations on a ring main, where it is converted into 660 D.C. and supplied to the various sections of the track. Normally two 33-kV feeders supply each sub-station through outdoor switchgear. From the bus bars linking the feeder breakers, the power is taken through a T connector *via* an isolating switch and rectifier breaker to the rectifier transformer, where it is stepped down to a suitable voltage for the A.C. side of the rectifier. The oil circuit breakers are motor and spring operated and can be controlled from three separate points, viz. by hand at the breaker operating gear, by remote control from the switch panel in the sub-station, or by supervisory control from the control room. Normally, the rectifiers are rated at 2500 kW corresponding to a full load of 3800 amperes, and are arranged to start up automatically as soon as the rectifier breaker is closed.

On the D.C. side the rectifier is connected to the D.C. bus bars through a main high-speed breaker rated at 4000 amperes. The supply to the various outgoing D.C. feeder cables is tapped off from this bus bar through 2500 ampere high-speed track feeders, each controlling its own particular section of the track. These feeder breakers have forward over current tripping, whilst the main high-speed breaker has only reverse protection. Each feeder is controlled from a contactor panel. Each supervisory control system is operated by D.C. at 128 volts, obtained from a 250-ampere hour battery in each control station. For charging these batteries there are in each case two 10-kW automatic motor generators. One is run off a 440-volt A.C. supply, and the other off a 660-volt D.C. supply. In each rectifier station there is also a 50-ampere-hour battery charged automatically through a metal rectifier.

In each control room there is a control switchboard built up of panels allocated to the respective rectifier sub-stations, track paralleling huts, and grid transforming stations, as well as an operator's desk fitted with a bank of fault signalling relays, a telephone exchange, and a set of calling switches for testing the various control circuits. All disturbances in normal working are indicated at the control desk, which can be considered as the nerve centre for the area concerned. On top of the desk, to be seen in Fig. 32, is the telephone exchange in the left wing, the fault relays with alarm bells in the right wing, while in front of the operators are the various calling switches and meters for checking the control circuits.

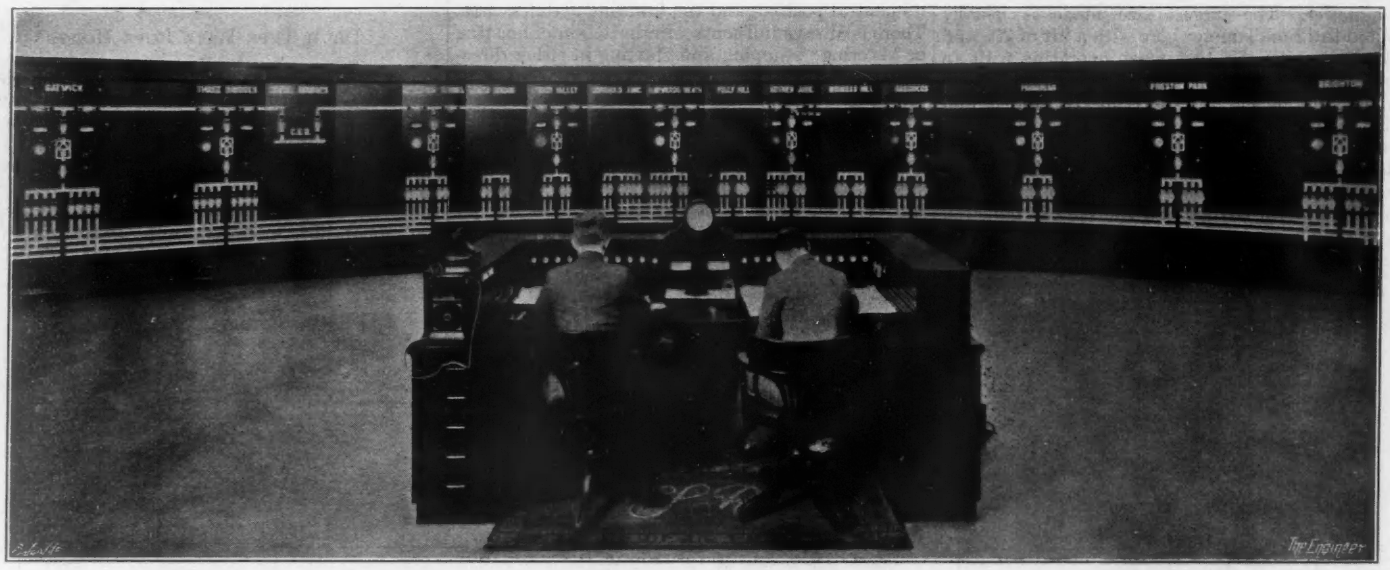


FIG. 32—TYPICAL CONTROL ROOM

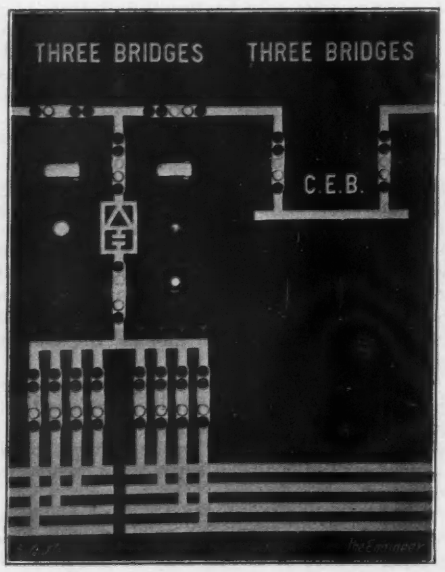



FIG. 33—CONTROL PANEL

On each panel of the switchboard in the background of the picture are remote control switches with indicating lamps and meters for the sub-station which the particular panel controls. The circuits are indicated in simplified form by a mimic bus bar system in which the various control switches, symbols, &c., are mounted so as to represent the positions of the apparatus in the various circuits. A close-up view of the panel for one of the rectifier sub-stations, with the portion on the right controlling the 33-kV switches in the Central Board's transforming station, is given in Fig. 33. On the rectifier sub-station panel is to be seen the T connection with the control switches and indicating lamps for the oil circuit breakers in each of the 33-kV feeders. Below these comes first of all the control unit for the rectifier oil circuit breaker, then a symbol representing the rectifier transformer and rectifier, an indicating unit for the main D.C. high-speed circuit breaker, and finally the D.C. station bus bars with the outgoing feeders, corresponding to the number of tracks to be fed, in each of which is a high-speed circuit breaker. On the C.E.B. panel can be seen the control switches with indicating lamps for the 33-kV breakers. Along the bottom of the panels are horizontal sections of bus bars representing the third rail track. At the top of each panel is a small white lamp which indicates by a flickering light any disturbance in the particular sub-station, as for instance when a breaker has tripped automatically. Meters on each rectifier sub-station panel indicate the rectified current and voltage. Below the left-hand meter is an indicating lamp, and, lower down, a check switch, both for the selector system. Below the right-hand meter is a synchronising orange lamp for the 33-kV feeder breakers, and, finally, lower down a calling switch with a combined pilot light for the two meters. It will be understood that these panels are used for the control and indication of the position of the breakers, &c., in the various sub-stations, the operating impulses to the breakers and the indicating impulses sent back from the breakers to the control room, all being transmitted *via* the ASEA selector system.

This system, as employed on the Southern Railway control scheme, uses only four pilot wires, over which no fewer than 200 different control impulses can be sent. This suffices for the complete supervisory control of three, but usually only two, rectifier sub-stations with the associated paralleling huts. Each group of selector control apparatus consists of one transmitter with auxiliary apparatus situated in the control room, and works in conjunction with two receivers, one at each of the remote controlled points. The transmitter and receiver are practically identical. The transmitter selector arm (Figs. 34 and 35) is given a step by step movement by a pawl mechanism operated by a step magnet. Electrical impulses between the transmitter and receivers keep them in exact synchronism as they rotate together step by step, but should the receiver fall out of step with the transmitter, the control and indicating circuits are at once broken and faulty operation or indication so prevented; but as soon as the cause of the trouble has been removed, synchronism is automatically restored.

The diagram, Fig. 36, relates to a single system of selector control, *i.e.* one transmitter controlling two receivers in two separate sub-stations, and shows some typical control and indicating circuits with the appropriate relays and other apparatus. The transmitter and two receiver instruments, items 18, 22, and 36 in the lower part of the diagram, each consist of a face plate with three concentric

rows of contacts. There are 50 contacts in each row, and over these contacts a contact arm (*e*) is rotated by the pawl mechanism actuated by the step magnet (*d*) (items 18, 22, and 36). At each step of the transmitter two contacts on the same radius and the apparatus connected to them are connected to a corresponding pair of contacts and associated relays on each of the receivers. By using polarised D.C. two different impulses can be sent through each contact. This means, for example, that on one selector one contact can be used to control both the closing and opening of a circuit breaker, while the other can be employed for indicating the breaker in the "on" and "off"

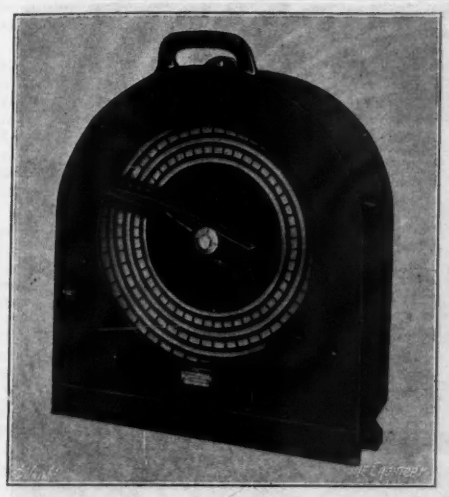


FIG. 34—SELECTOR—FRONT VIEW

positions. The third ring of contacts on each instrument is used to control the synchronous forward motion. Connections for the contacts are brought down to a terminal plate in the base of the selector. External connections are brought to a corresponding terminal bed at the bottom of the cover. Each transmitter and receiver instrument is designed as a complete self-contained unit provided with a handle at the top so that it can be disengaged, dropped forward, and lifted out of its case for repairs or replacements. Moreover, each unit is designed and connected as a duplicate of the corresponding units so that one transmitter is interchangeable with any other, and any receiver can, if necessary, be exchanged with a receiver in

FIG. 35—SELECTOR—BACK VIEW

another sub-station. In addition to the main contact row the transmitters and receivers have a number of auxiliary contacts operated by the step magnet arms in the positions when the latter pass from contacts 50 to 1, the function of these contacts being to bring the instruments automatically back into synchronism should they drop out of step.

The synchronous forward motion of the selector works as follows. By pressing the call switch *b* on one of the control units 1 to 4 near the top of Fig. 36, the selector is called to any given position. This operation closes a certain relay in the relay equipment 17, in the lower left-hand part of the diagram, and connects the step magnet *d* (item 18), whose plunger is pulled down and compresses the spring *f*. When the plunger reaches the bottom of its stroke a limit switch breaks the circuit, the spring returns the plunger to its initial position, and in doing so moves the contact arm one step forward. While the plunger is moving upwards again contact *a* (group 17) is in the position shown, and contact 17*b* is closed, allowing an impulse to be sent out from the positive pole of the battery over pilot conductor 1, which is the synchronising conductor. At the first instant this circuit is closed, the impulse gets no further than the first receiver station on the line, since the line is connected to the neutral of the battery at that point by contacts *a* and *b* (group 23). The quick acting relay *s* (group 23) is, however, energised and breaks its contact *a*, allowing the impulse to proceed to the next station, where the relay *s* in group 37 is energised in the same way. When 23*s* and 37*s* are energised their contacts *d* close and complete the circuits for the step magnets 22*d* and 36*d*, their plungers being pulled down and kept in that position as long as the impulse lasts. When the plunger of the step magnet 18*d* on the left of the diagram has nearly returned to its upper position, contact *b* (group 17) breaks the circuit and the impulse is cut off. Contacts 23*d* and 37*d* then break, the step magnet plungers of the respective receivers are forced up by spring action, and the contact arms make a corresponding step forward.

At the beginning of the upward movement, contacts *b* on the respective receivers close in their bottom position, and the more remote of the

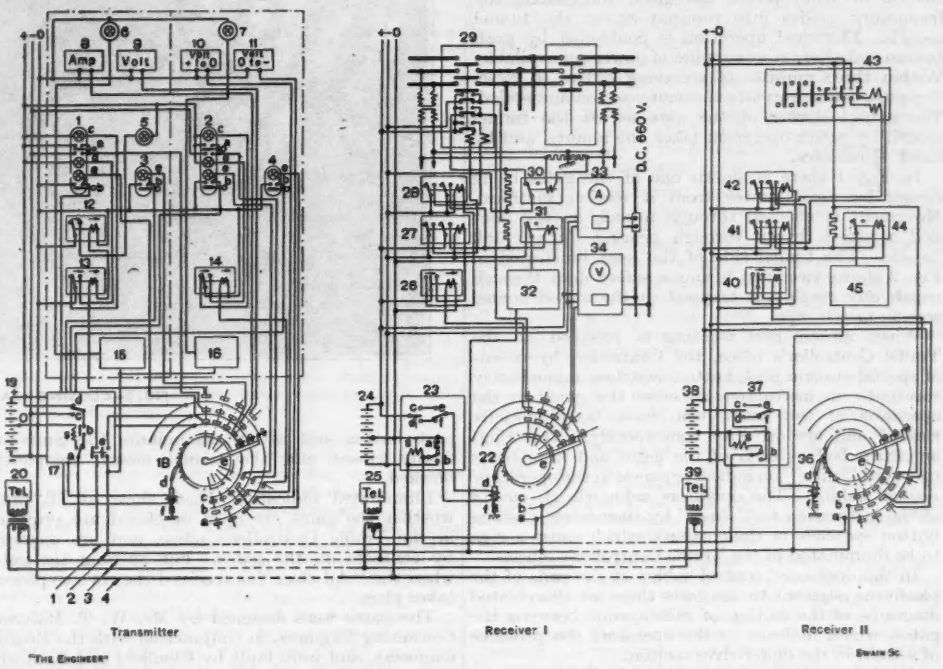



FIG. 36—DIAGRAM OF TRANSMITTERS AND RECEIVERS

two receivers sends a check impulse back over the synchronising wire from the positive pole of the end battery. Only one of the intermediate receivers is shown in the diagram, Fig. 36, but if all the intermediate receivers have correctly advanced one step, their respective contacts *b* will be closed, short-circuiting relay coils *s* (group 23) and the check impulse will arrive back at the transmitter and operate a relay to indicate that synchronous working is being attained. But in the event of one of the receivers having failed to move forward the required step, its contact *b* will not have closed in the bottom position, and the check impulse will be stopped at that point. The selector check relay will not, therefore, receive any check impulse, and arrangements will immediately be put into action automatically for the restoration of correct synchronous operation. Until this is done and the transmitters and receivers are all correctly synchronised, the control and indicating pilots will remain broken by the contacts *e* (group 17) and faulty control or indication made impossible. It will thus be seen that for every single forward step made by the transmitter, there is an automatic check that all the associated receivers make a corresponding step, this being brought about by the last receiver on the system sending a check impulse back to the originating station.

When the step magnets in the receivers are near the end of their upward stroke, the respective contacts *b* close again in their upper position and the check impulse ceases. The circuit is then ready for the next impulse to be transmitted.

Since the transmitter step magnet is already moving down again while the receivers are sending back the check impulse for the previous impulse from the transmitter this will follow at once. In this way the receivers are progressively stepped round until they reach the called position over which the desired control operation is to be performed. The transmitter is stopped in this position by the contact arm connecting a stopping relay included in the group 17 to the corresponding contact on contact row *c* (item 18) to neutral *via* a lamp *e* and contact *b* of the control unit 3 near the top of the diagram from which the whole calling sequence was originated. The purpose of the lamp *e* in circuit with the call switch *b* is to indicate when the selector system has been called to the correct position, so that the desired control operation can be performed. Should any of the receiver instruments have dropped out of step, however, an interlock on the stopping relay will keep it from acting, and allow the selector to keep on rotating until the receivers are in step again. Hence the transmitter does not stop until all the receivers are on the position called.

If a receiver drops out of step with the transmitter, the whole system is automatically restored to synchronism in the following manner. The receiver that has fallen out of step, say, for example, No. 22, continues to rotate with the time lag until its arm reaches contact No. 50. In this position contact *f* (group 23) breaks and contact 23*e* makes circuit. Hence the step magnet is made inoperative until contact *c* of relay 23 closes. This happens the next time the transmitter comes round to position 50, where the contact *d* (group 17) breaks and 17*c* sends out a negative impulse in this position of the transmitter. The negative impulse makes the polarised relays 23 and 37 close their contacts *c*, again energising all the step magnets and causing the receivers to move one step forward. In the position I of the selector contacts, 17*d*, 23*f*, and 37*f* reclose, positive impulses are again sent out from the transmitter, and the system is back again in synchronism. A negative synchronising impulse is thus always sent out in position 50.

The working condition of the selector system is indicated by a lamp on the appropriate control panel. When the selector is moving forward in synchronism the lamp flickers in time with the steps, and when it is at rest in synchronism it burns steadily. If the system drops out of synchronism the lamp goes out and will not light again until synchronism is restored. When re-synchronised after being out of step, the selector system automatically makes an extra complete revolution to ensure that all indications are correct. Other parts of Fig. 36 will be referred to in the next article.

*(To be continued)*

THE "TRAFFICSCOPE."—As an experiment what is known as a "Trafficscope" has been installed in Illinois, south of Springfield, to aid motorists using a steep viaduct over the Illinois Central Railroad. Consisting of four banks of 40in. glass prisms suspended 15ft. above the highway, the "Trafficscope" is said to provide visibility for a distance of 2000ft. or more. In the past the steep gradients on the viaduct approaches limited the visibility to 500ft.

K

## Protective Works on Underground Railways

IN conjunction with the Ministry of Transport, the London Passenger Transport Board has undertaken an extensive programme of emergency works in order to protect its transport services from any possible risks which might arise from air raids. The cost of this programme, much of which had been completed before the outbreak of war, will be about a million pounds. One problem of some magnitude is the protection of the underground railways from any possible risk of flooding, either from the Thames or from the sewers or water mains, where they are in close proximity to the stations.

One method of protection adopted is the installation of floodgates at certain of the stations, and when the works at present in hand are completed, all the stations and sections of the line, at present closed, will be reopened and travel on the Underground will be as safe as hitherto. Until these permanent works have been completed the complete safety of the public is ensured by temporary means. In the accompanying illustrations is shown one of the electrically operated floodgates which have been installed for the purpose of closing the tunnels in the event of an air raid. These gates are designed to resist a pressure of 800 tons, and each is built up of steel with an overall thickness of 13in. and weighs just under six tons. They are set in a framework of cast iron against the headwall of the station platforms, alongside the tunnel mouth. Under either electric or hand power the gates slide along the framework guides into position across the tunnel mouth. Electrical operation is controlled by push button and alternative supplies of power are available. Within three minutes of receiving orders to close, the gates can be run into the shut position and sealed. The actual closing of the gate across the tunnel mouth by power operation takes one minute, and by hand 4½ minutes.

In Fig. 1 there is shown one of the gates being closed by hand power from a station platform. Movement is effected through a rack on the door and a pinion driven through gearing by a crank handle. The tunnel side of the door illustrated in Fig. 2 shows two men lifting a safety door through which any employees trapped in the closed tunnel section may escape.

When an air raid warning is received at the Traffic Controller's office, the Controller, by means of special electric push-button switches, immediately transmits an instruction to close the gates to the operators of the gates, who have been specially trained and are on duty continuously. This rings an alarm bell at each of the gates and illuminates the word "close" on indicator panels in the operators' control cabins. The operators acknowledge receipt of the instruction to "close" by themselves pushing button switches in their cabins, which cause a sign to be illuminated in the Traffic Controller's office.

In the operators' control cabins at the ends of the platforms adjacent to the gates there are illuminated diagrams of the section of railway line between the gates, which indicate to the operators the presence of a train in the under-river section.

As soon as the operators have satisfied themselves by means of the diagrams that all the trains have cleared the sections of line between the gates—the maximum time for a train to clear would be 2 minutes—the closing of the gates can be proceeded with. In order to prevent the possibility of a gate being closed while there is still a train in the under-river sections of tunnel, interlocking devices are provided which would prevent the gates being closed in such circumstances. The next step is to fill in the gaps in the gate sill which provide spaces for the rails, so that a continuous runway is provided across the tunnel mouth over which the floodgates can slide into position. This is done by the operators fitting special metal sealing blocks with rubber linings into the gaps. The gate motors are started by a push button and within one minute the gates are finally closed and the tunnel mouth completely blocked.

Illuminated indicators which show at all times whether the gates are open or closed are provided in the Traffic Controller's office, and are operated by contacts on the gates. For opening the gates when the "All clear" is received the reverse process takes place.

The gates were designed by Mr. W. T. Halcrow, Consulting Engineer, in conjunction with the Board's engineers, and were built by Glenfield and Kennedy, Ltd.

Following upon the September crisis a year ago, the Board's engineers made a survey of the whole of the underground stations to determine what constructional alterations would be required to eliminate the possibility of flooding from burst water mains and sewers which run through or near the stations. As a result of this survey, fifty stations were found to be in need of some protective measures. At thirty-one of these the necessary work could be done without disturbing the traffic using the station and had already been completed at the outbreak of war.

At the remaining nineteen stations the engineers were faced with more complex problems, some of them of an entirely novel character, and it was found that the necessary work could not be done without the stations being closed entirely. King's Cross Tube Station illustrates the type of problem that has had to be faced. Every one of the subway entrances to the sub-surface ticket hall is threatened by the proximity of sewers and water mains. At one point, for instance, the floor of one of these subways is only six inches above the roof of the Fleet sewer, one of the largest sewers in London. Two other subways pass alongside and over the St. Pancras sewer, which was diverted at the time of the construction of the new underground ticket hall from a line which ran through the centre of the ticket hall site.

As the proximity of all these sewers and water mains presented a risk of flooding in the event of any of them suffering damage, the only immediately practicable method of protection was to block up the four passages leading from the circulating area at the foot of the main flight of escalators to the Piccadilly and Northern lines by inserting bulkheads of solid concrete between 5 and 6ft. thick, shutting off completely the top station from the platforms and tunnels below. Two days before the outbreak of war the station was closed to enable the work to be done. As it is not possible to strengthen sufficiently the surrounds of the subways and the mains and sewers which they conceal to prevent the station from being flooded should they be damaged during an air raid, the circulating area at the foot of the main escalators is being used as a trap for any possible inflow of water. Permanent works are now to be carried out which will provide security and enable the station to be opened to traffic again. Three of the concrete bulkheads are to be removed from the passages leading to the tube lines and replaced by manually operated steel bulkhead doors, which can be rapidly closed. This work is to be completed by the end of December.

FIG. 2—CLOSING GATE FROM TUNNEL SIDE

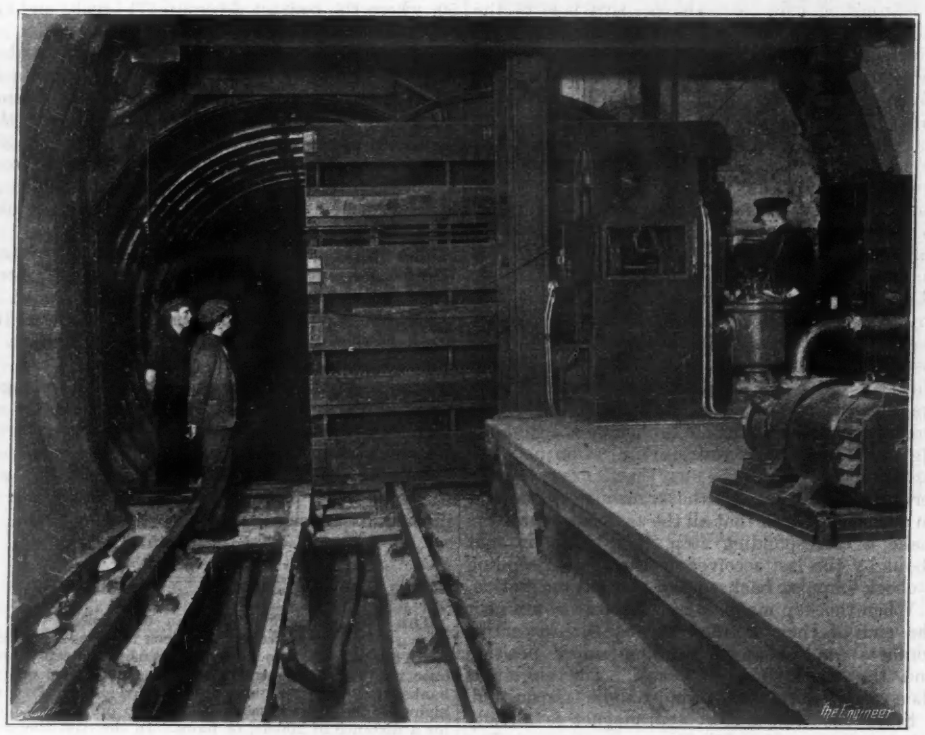


FIG. 1—TUNNEL CLOSING GATE FROM PLATFORM SIDE

WEIGHT OF VEHICLES RESTRICTIONS.—Representations have been made to the Minister of Transport by the Public Service Transport Association asking that the present maximum laden weight of omnibuses and trolley vehicles should be waived. The use of aluminium is now restricted to war purposes and, consequently, it is necessary to use other materials instead of aluminium in the construction of these vehicles. The increase in unladen weight which such a course necessitates would mean that, to keep the vehicles within the present limits of permissible laden weights, the seating capacities would have to be reduced.

## Rail and Road

TROLLEYBUSSES IN LONDON.—On Sunday, December 3rd, the last tramways in North London, except those services linking with South London through the Kingsway subway, will be replaced by trolleybuses. This route is the No. 11 between Highgate Village and Moorgate, and includes the Highgate Hill, one of the steepest climbs on which tramcars have been running in London.

JAPANESE RAILWAY PROJECT.—It is reported in the Japanese press that the Railway Ministry has decided to construct a new electrified line between Tokyo and Shimonoseki at a cost of about 1000 million yen. An aerial survey of the 450 miles route has been carried out and a geological survey is now in progress. The line will be standard gauge and its construction will include the boring of a tunnel through Mount Suzuki, near Osaka.

RAILWAY COLLISIONS IN GERMANY.—It is reported that nine persons were killed and twenty seriously injured in Germany on Sunday, November 19th, when a Berlin–Hamburg express ran into a local train near Spandau. On Monday, November 13th, forty-three persons lost their lives in a head-on collision between two local passenger trains on the single line branch between Casel and Bauerwitz at a point between Langlieben and Rosengrund.

RAIL ECONOMY IN DENMARK.—The Danish State Railways have established a central rail welding depot at Frederica where new rails, which are purchased in 15-metre lengths, are flash butt welded together into 30-metre lengths. At this depot the ends of old rails are being cut off and they are then welded together to form complete lengths. Old 37-kg. 12-metre rails have half a metre cut off and are joined together to form 23-metre rails, and old 45-kg. 15-metre rails are welded to form 29-metre lengths.

EXPERIMENTAL WORK ON ROADS.—The report for 1938–39 of the Experimental Work on Highways (Technical) Committee describes the full-scale experimental work carried out by the Ministry of Transport on roads in Great Britain in connection with concrete, cement-bound macadam, tar and other bituminous surfacings, thin surfacing coats, surface dressing, footpaths in rural areas, and cycle tracks. The introductory chapter reviews the general trend of the Ministry's experimental work, and the sectional introductions to each of the succeeding chapters summarise the progress made in each field of investigation.

SAFETY ON AMERICAN RAILWAYS.—At the National Safety Congress held recently at Atlantic City, it was stated by Mr. M. J. Gormley that he considered 1938 the safest in American railroad history. He pointed out that in 1923 there were 27,497 train accidents on the railroads of the United States, or at the rate of 22 accidents per million train-miles. In 1938 the number of such accidents was 5682, or at the rate of less than 7 per million train-miles. In other words, the frequency of such accidents was reduced by 69 per cent. Only a small percentage of train accidents, about 7 per cent., result in casualties of any kind to persons. The amount of damage to railway property in train accidents, including cost of clearing wrecks, was 27,625,000 dollars in 1923, which was reduced to 9,082,000 dollars in 1938. The cost of these accidents was 2·22 cents per train-mile in 1923 and 1·09 cents per train-mile in 1938.

NEW SOUTH WALES RAILWAYS.—The annual report of the Commissioner of the New South Wales Railways shows that during the year 1938–39 the train mileage totalled over 30 millions, the passenger journeys totalling nearly 187 millions. The profit on operations totalled £4,603,461, a decrease on the previous year of £1,122,667. During the year steady progress was made on the new Sutherland to Cronulla Railway, all the earth and drainage work being nearly completed. On the Bungendore to Captain's Flat line earthwork was rapidly pushed on and rails were laid for a distance of 9½ miles near Hoskinstown. Of the 124 miles length of the Sandy Hollow–Maryvale Railway 106 miles of earthwork were completed, and work on the five tunnels was in hand. A survey of the 18 miles long Gwabegar–Philliga Railway which has been authorised was completed in June. The report states that the provision of a new structure to replace the Hawkesbury river bridge is absolutely essential and its erection must be completed with the utmost speed.

READING LIGHTS ON L.M.S. SUBURBAN TRAINS.—During the past month the London, Midland and Scottish Railway Company has fitted approximately 160 main line passenger trains with lighting which enables passengers to read in comfort. The equipment of steam suburban trains with a system which would give enough light for reading and yet comply with regulations has been a much more difficult job, owing to the use on these trains of coaches having compartment doors, and the greater number of stops at stations. By collaboration between railway and Government experts, however, these difficulties have now been overcome, and the company recently demonstrated, on a London suburban train, the system which will be made general as rapidly as the supply of material permits. The amount and type of lighting provided varies with the class and type of coach, but the general practice is to have four white shoulder-lights, each of 15 watts, in first-class compartments, together with one blue light in the roof. In the case of third-class compartments, one type of coach has two white roof lights, each 15 watts, and one blue centre light, whilst the other type has a single 60 watts central roof light. In every case the white lights are screened with metal shades having matt-black interiors, throwing the light down over the seats so as to enable passengers to read in comfort, but cutting off the beams from shining directly out of the compartment door-window. The side blinds to all windows will be drawn down during hours of darkness, the edges of the windows being blacked-out as on main-line trains. Only the top half of the door window is blacked out, however, the lower half (which does not allow light to escape) being available for passengers to note at which station a train is stopping, or for late-comers to see whether a seat is vacant or not.

## Miscellanea

THE CONTROLLER OF SALVAGE.—Mr. H. G. Judd has been appointed Controller of the Salvage Department of the Ministry of Supply which is being formed to take general control of the collection and salvage of waste products.

EXPLOSION AT VALLEYFIELD COLLIERY.—The Secretary for Mines has directed that a formal investigation shall be held into the causes and circumstances of the explosion which occurred in the Diamond Seam of the Valleyfield Colliery, Culross, Fife, on the 28th October, 1939. He has appointed Mr. R. P. Morison as Commissioner, together with Sir Henry Walker, as Technical Assessor, to hold the investigation.

MINISTRY OF SUPPLY EXPENDITURE.—It was recently stated by Mr. Burgin that during the first eighty days of war the Ministry of Supply had placed orders to the value of 183 million pounds. Of this sum, about 50 million pounds has been spent on guns and ammunition, 50 million pounds on vehicles and mechanisation, 30 million pounds on equipment and uniforms for soldiers, 10 million pounds on machine tools, and 10 million pounds on scientific instruments.

THE INSTITUTE OF METALS.—At a formal general meeting of the Institute of Metals the under-named nominations were made to fill vacancies occurring on the Council next year: President, Lieutenant-Colonel The Hon. R. M. Preston; Vice-Presidents, Dr. S. F. Dorey, Engineer Vice-Admiral Sir George Preece, and Mr. A. J. G. Smout; Honorary Treasurer, Lieutenant-General Sir J. Ronald E. Charles; Members of Council, Dr. W. E. Alkins, Mr. G. L. Bailey, Mr. F. C. Braby, Colonel P. G. J. Gueterbock, and Dr. D. Hanson.

PRESTON POWER STATION EXTENSIONS.—A recommendation of the Electricity Committee that extensions costing £701,453 should be carried out at Preston power station was confirmed by the Town Council. The proposed extensions, which would adjoin the existing power station, comprised the first stage of a 31,500-kW turbo-alternator set with auxiliary plant and 187,500 lb. per hour boiler units. The design and lay-out have been prepared on the basis of a total ultimate capacity in the new station of 126,000 kW or four 31,500-kW sets.

BRUSSELS FAIR, 1940.—In connection with the Brussels International Industries Fair which is to be held in March, 1940, the *Belgian Review of International Trade* is being published in Dutch, English, French, German, Italian, Portuguese, and Spanish. It will contain an illustrated description of the premises, stands, goods with all technical details, together with the names and addresses of firms and works, in fact everything that will be displayed in March, 1940, in the eleven halls of the F.I.I.B., covering a floor space of 65,000 square metres and comprising 2750 stands. Application for copies—free—should be made to Foire Internationale de Bruxelles, Palais du Centenaire, Brussels, 2, Belgium.

THE USE OF DIAL GAUGES.—In the opinion of Dr. George Schlesinger, Director of Research, Institution of Production Engineers, the arms of dial test indicator stands are generally too weak. The deflection of the arm is made by the weight of the dial gauge which is about 6½ ounces plus or minus another 1½ to 6 ounces spring pressure. These forces bend the arm considerably and in particular are of decisive influence when the stand of the gauge is no longer stationary but used by causing it to rotate on a horizontal axis. An arm consisting of a steel tube of 3½in. outside diameter and 3in. bore, 10in. long, provided with an angle piece or two at right angles, welded to avoid any joint, with a slot for the lug of the gauge, long enough to give the dial plunger the scope from the centre (zero) to 3½in. diameter is recommended. This tube allows testing mandrels of any diameter up to 2⅞in. to enter its bore to the full length of 6in., 8in., 10in., or 12in.

INTERNATIONAL ELECTROTECHNICAL COMMISSION.—In present circumstances the work of many international organisations has necessarily been curtailed or even suspended. It is therefore of interest to learn that during the war it is proposed to maintain the Central Office of the International Electrotechnical Commission in London. It will probably not be possible for meetings of the Technical Advisory Committees to be held during the war, but as much as possible will be done by correspondence with a view to bringing to a conclusion all work which was nearing completion at the outbreak of hostilities. It is felt that the National Committees may like to have the benefit of the work already accomplished, and as many as possible of the draft specifications which have been under consideration during the last year or two will, it is hoped, be issued as Provisional I.E.C. Recommendations. In the meantime, copies of all existing I.E.C. publications are still obtainable from the General Secretary of the I.E.C., 28, Victoria Street, London, S.W.1.

HOME-GROWN AND EMPIRE TIMBERS.—The Forest Products Research Laboratory of the Department of Scientific and Industrial Research has just issued a revised edition of the handbook on "Home-grown Timbers" and a companion volume "A Handbook of Empire Timbers." This latter volume contains a large amount of new information on the increasing number of Empire timbers offered in the home market which has become available since the publication of a handbook with a similar title in 1932. The volume on home-grown timbers covers 26 hardwoods and nine softwoods, while that on empire timbers covers 79 hardwoods and 17 softwoods. The sections devoted to each species contain descriptions of the tree and its timber, and include notes on its seasoning and mechanical properties, suitability for bending, wood-working properties, natural durability and resistance to insect attack, and preservative treatment. Other paragraphs contain information on the most suitable uses of the various species of timber and their main sources of supply. Where possible reliable shrinkage figures are cited for each species, while particulars of kiln seasoning schedules and figures for mechanical strength are provided as appendices to each volume.

## Air and Water

SHIPBUILDING IN JAPAN.—The Japanese Ministry of Communications has approved the construction of thirteen cargo ships, a tanker, and one other unspecified vessel, during the current financial year.

THE BRITISH MERCANTILE MARINE.—In the week ending November 12th, the British Mercantile Marine showed a substantial increase in strength of 24,000 tons after deduction of losses, this increase being brought about by the completion of three new ships, two captures, and a conversion.

AMERICAN AIRCRAFT FOR BRITAIN.—The last of 250 Hudson reconnaissance bombers ordered in June, 1938, by the British Air Ministry from the Lockheed Aircraft Corporation was completed in the week ended November 25th, 7½ weeks ahead of contract time. The machines were built at the rate of six per week.

CHIEF OF NAVAL AIR SERVICES.—The King has approved the following appointments: Vice-Admiral Guy C. C. Royle to be a Lord Commissioner of the Admiralty and Chief of Naval Air Services in succession to Vice-Admiral The Honourable Sir Alexander R. M. Ramsay, and Captain Edward N. Syfret to be Naval Secretary to the First Lord of the Admiralty in succession to Vice-Admiral Royle.

LOSS OF H.M.S. "GIPSY."—The Admiralty announces the loss of the destroyer "Gipsy" which was sunk through striking a mine off the East Coast on Tuesday, November 21st. The vessel was subsequently beached. This ship was one of the "Greyhound" class and was completed in February, 1936. With a displacement of 1335 tons she carried an armament of four 4·7-in. and seven smaller guns and eight 21-in. torpedo tubes.

INSTITUTION OF NAVAL ARCHITECTS SCHOLARSHIP.—It is announced that the Elgar Scholarship in Naval Architecture, which is tenable for three or four years, according to the length of the course at the University selected, will be offered for competition in 1940. The scholarship is valued at £130 per annum, and entries for it close on January 15th, 1940. Full particulars may be obtained from the Secretary of the Institution of Naval Architects, 10, Upper Belgrave Street, London, S.W.1.

NEW SOVIET FLOATING DOCK.—The Marty Shipyards in Odessa has completed the assembly of a new ferro-concrete floating dock intended for the inspection and repair of the underwater parts of the hulls of sea-faring vessels, The new dock, which is capable of lifting vessels of 6000 tons, is equipped with its own boiler installation and electric welding and compressor plant. The length of the dock is 426½ft., the width 100ft., and its height 48ft. In successful tests it has raised the electric vessel "Trud," weighing 5400 tons.

MORE LINERS IN TRANSATLANTIC SERVICE.—It is reported that four Prince Line vessels formerly employed between New York and South America are shortly to be put in service between New York and London. Of about 11,000 tons these ships have a speed of 16 knots, are equipped to carry 100 passengers each as well as fresh fruit and frozen produce, and have besides facilities for lengthy and heavy packages up to 50 tons in weight. The company's service to South America, it is added, will be maintained with other tonnage.

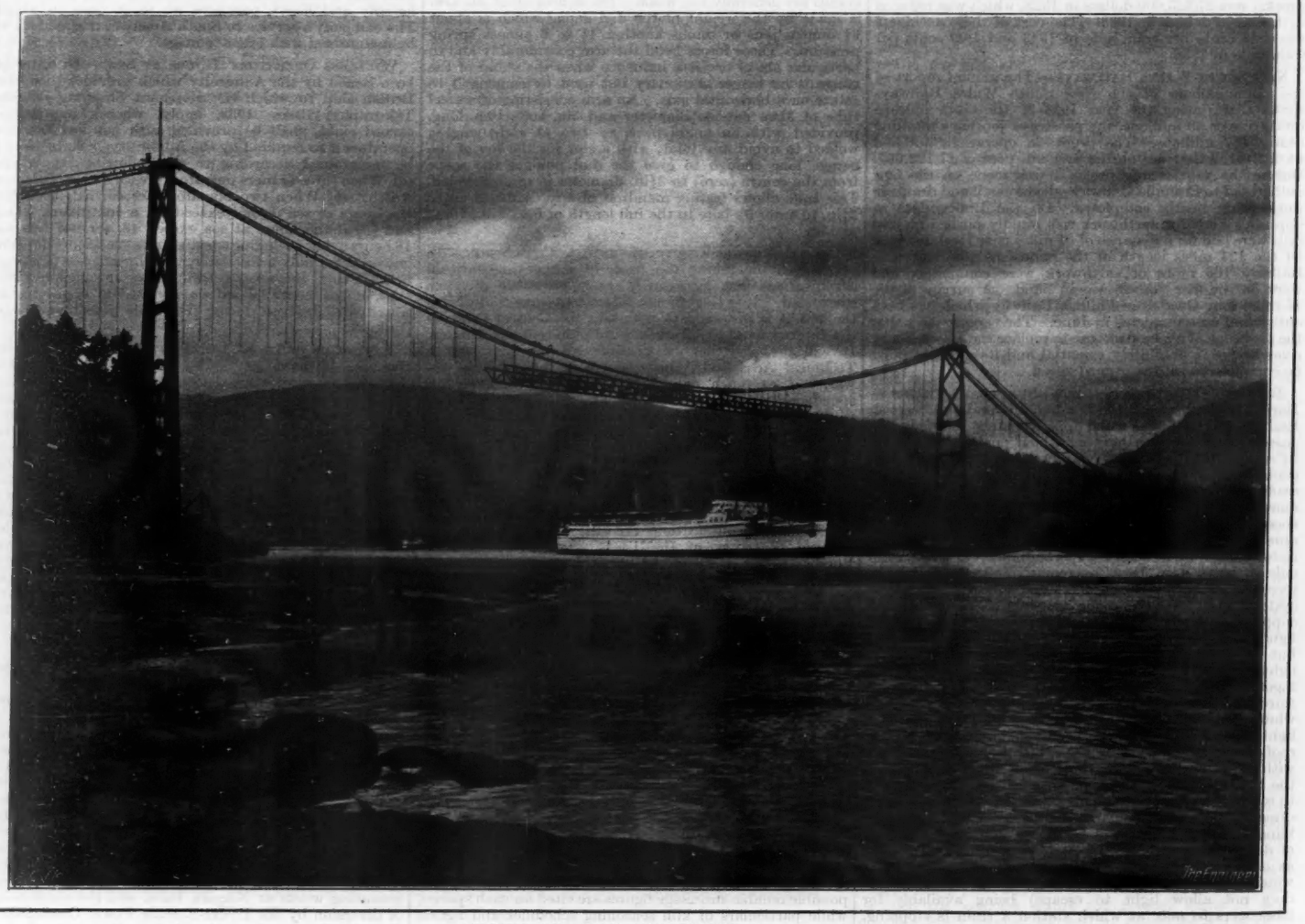
WIRELESS OPERATORS' HOURS AT SEA.—An order has been issued by the Admiralty which provides that every British ship to which the Merchant Shipping (Wireless Telegraphy) Rules, 1938, apply, whose hours at sea exceed eight, shall be provided with not less than two operators if so required by the Admiralty. Watches must be maintained according to the following regulations: (*a*) When three or more operators are carried, a continuous watch. (*b*) When two operators are carried, then (i) if the hours at sea do not exceed 48, a continuous watch; and (ii) if the hours at sea exceed 48, for not less than 16 hours a day, including certain times specified. (*c*) When one operator only is available, then for not less than eight hours a day, including certain times specified, provided that, if the hours at sea do not exceed eight, wireless watch shall be kept during the whole time that the ship is at sea.

DETECTION OF LOOSE METAL IN AIRCRAFT LUBRICATING SYSTEMS.—The house journal of Fletcher Miller, Ltd., describes an interesting device for the detection of loose metal fragments in the oiling system of aircraft engines. One arrangement of the device consists of a grating of metal rods set in the pipe-line, alternate rods being connected with one pole of the electric generator and, *via* a warning light, with the opposite pole. The warning light is set in the cockpit of the machine and any metal fragments too large to pass through the grating complete the circuit and switch the light on. Fine metallic particles produced in normal engine operation are passed without the warning being given. An alternative arrangement whereby a special plug performs the same function as the grating is also described. The device is the invention of M. van Os of the Royal Dutch Air Lines, and the article states that at least twelve cases of engine failure in flight have been averted by warnings given by it.

PROJECTED ST. LAWRENCE CANAL.—A note in the *Canadian Engineer* states that according to reliable sources negotiations are to be opened between the Dominion and United States Governments for the immediate undertaking of the St. Lawrence Seaway Canal and power sites development. The project, it is understood, will call for an expenditure on the part of the United States of 246,661,000 dollars, and by Canada of 38,071,000 dollars. It would include the deepening of the International Section of the St. Lawrence River, between Cornwall and Prescott, Ontario, and deepening from Lake Erie to the Head of the Lakes by the United States, in addition to deepening between Montreal and Cornwall, by Canada, together with the deepening of the Welland Canal. The plan also contemplates construction of compensating works at Niagara Falls, and the authorisation of diversion by the Hydro-Electric Power Commission of Ontario of water from the Hudson Bay watershed into Lake Superior.

# LIONS GATE BRIDGE, VANCOUVER, BRITISH COLUMBIA

(*For description see page 534*)



SOUTH SIDE-SPAN AND TOWER
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# The Engineer

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### 'TWIXT FLOOR AND CEILING

RECENT Press accounts of air fighting at widely different altitudes from as far up as the height of Mount Everest to as low down as within a hundred feet of the sea, make the reader wonder what settles the optimum height for air fighting. For the attacker, a low level contact may seem at first sight best, for there is at least one direction in which the enemy cannot safely escape. On the other hand the fighter's engines are designed to give their best many thousand feet up, and they cannot freely use their full power low down. Moreover there is usually a best spot on the target aircraft—the so-called blind-spot—at which the attack should be delivered, and as this is usually behind and sometimes below, the most effective firing position is difficult to attain in very low level flying. The fighter likes plenty of air room in which to manœvure for position and without it feels cramped. On the other hand flying at a height of five miles or more means that the crew have the complication of oxygen supply for breathing, and every movement calling for high accuracy becomes somewhat more troublesome. Indeed in the limit when flying close to the ceiling any nicety of manœuvre becomes impossible. So both the one extreme of altitude and the other are alike in making things difficult for decisive action. High flying has, however, the advantage for the crews of both machines in that escape by parachute is possible, as it would certainly not be while flying close to the ground.

More than twenty years ago Mr. F. W. Lanchester introduced what he called his "N squared law," and argued that the fighting power of a number of similar units—whether ships or aeroplanes—was proportional not to the numbers engaged on each side but to the squares of those numbers. Thus three similar ships would be nine times as powerful as one; and twenty-seven similar aeroplanes nine times as strong as only nine. The aeroplane figures given for purposes of illustration are intentionally those of the recently cited attack by nine French aeroplanes against twenty-seven German, when nine of the German were destroyed and none of the French, and show how little similar can have been the French and German aircraft, or the crews using them; an encouraging conclusion. The Lanchester law seems surprising at first since one might have expected that on almost any theory two aeroplanes would be twice as strong a fighting force as one, and not four times. But if one pictures two aircraft A and B fighting a similar aircraft C, all alike carrying say, 1000 rounds, then A and B can each fire their 1000 rounds, making a total of 2000 fired at C, whereas C can only fire 500 apiece at A and B, and this gives the Lanchester ratio of four in bullets received (or receivable) per aeroplane. Herein the tacit assumption is made that the chance of lethal injury is directly proportional to the number of bullets fired, and given equal skill in gunnery that is a fair assumption. This makes the picture seem a rosy one for the massive formation. But it is important to remember that the theory is based on the assumption of clear fields of fire, and it must, of course, break down when any of the aircraft on the same side blank each others' guns so that their operation has to be suspended; and the larger the formation the more blanking there must be. To design a shape of formation such that blanking could not occur, especially where the numbers are really great, is not possible. This makes it necessary to accept a limitation to the applicability to air warfare of the Lanchester theory (as its author would certainly admit)—and yet another most important limitation arises through the greater ease of manœuvre by a small formation leading to a greater probable accuracy of fire, as well as affording a much better choice of firing position.

These reasons raise serious doubts whether success in warfare, despite the apparent encouragement of the "N squared law," can be obtained by using massive formations either in attack or defence. Moreover, against large formations, anti-aircraft action from the ground becomes increasingly easy as the numbers go up, whilst the chance of air collisions, when under attack, must be considerable. Although it may be picturesque to paint the sky as dark with attacking aircraft, it is not a picture which seems likely to materialise against any well defended target—for it would be an experiment which there would be little temptation to repeat.

### Technical Institutions in War Time

ON another page of this issue we print a short review of the manner in which a number of the engineering technical institutions are carrying on activities under war-time conditions. These activities are, of course, greatly influenced by the necessities of modern warfare, the prosecution of which makes heavy demands upon technical knowledge and skill. Though, from the review it might appear that the war had exercised a solely restrictive effect, it is in fact probably true to state that the Institutions have never been more busily employed than they are at present. It is the orientation of their activities that has suffered change. Pressed by the necessities of war they have been forced to be active less in forwarding the interests of those spheres of engineering which are their particular and individual concerns than in striving to aid the Government and their own members to carry out work of urgent national importance. Thus, to take a few instances at random, the Institute of Metals and the Iron and Steel Institute expected from experience in the last war, and have already experienced in this one, that the number of urgent inquiries reaching their information bureaux would rapidly increase; the Institute of Welding Engineers is co-operating with the Government in devising schemes for the rapid training of welding supervisors and operators; and the research station staff of the Institution of Automobile Engineers holds itself ready to undertake urgent investigations arising out of the war-time use of mechanically-propelled vehicles. All the Institutions are similarly doing such work as they are best qualified to perform by providing information and undertaking research, and are co-operating in every way they can with the appropriate Government departments. Not the least important of their activities is that concerned with the compilation and use of the "National Register," which contains particulars of the qualifications and experience of technical men throughout the land, and which has largely been compiled from the records obtained, at very short notice, in September last year by the Institutions themselves. In one activity alone do the Institutions appear impatient of restraint. It is to their great credit that despite the heavy increases of responsibility which they now bear, and the considerable disruption of their normal routine, they have continued to recognise that the education of youth still remains of over-riding importance. Some dislocation of educational activities, such, for instance, as the cancellation of the conference planned by the Institution of Civil Engineers to take place in the spring, was inevitable. But the Institutions have firmly determined to continue to hold examinations, to award diplomas and certificates, and generally to encourage the young engineer to seek new knowledge.

The more immediately apparent effect of the war upon the activities of the Institutions is that of interfering with their meetings. Twenty-five years ago the risk from air raids was relatively so remote that meetings could be held with nearly the same freedom from apprehension as in peace time. But to-day the risk is greater and the night "black-out" more severe. In the belief that during the first weeks of the war London and other large centres would be the subject of severe and frequent aerial attack, the majority of the Institutions decided at once to cancel all meetings, social or otherwise, and to rely upon their "Journals," "Transactions," and "Proceedings" to keep them in touch with members. Since that time, and despite the absence of aerial attack, the severity of the evening "black-out," the transfer in some instances of office staffs to country quarters, doubts

as to the numbers of members likely to be attracted and a number of other factors have influenced the institutions to hold at least temporarily to their original decisions. Signs are, however, not wanting that some at least may soon relax the severity of the ban. Those that have already been bold enough to experiment have found their fears unjustified. The first meeting of the Junior Institution of Engineers, for instance, was so successful that subsequent meetings have been held each fortnight instead of once a month as originally intended. In the provinces the ban on meetings has been less complete, and all varieties of arrangement can be found, from total abandonment to the holding of the complete programme as arranged before the war broke out. The Institution of Engineers and Shipbuilders in Scotland, for instance, whose headquarters are in Glasgow, is holding evening meetings once a month, and has made the sole concession to the "black-out" that dates are chosen which fall at periods near full moon.

In a leading article published soon after the outbreak of the war we stressed the value to engineers of the verbal discussion of papers, particularly in time of war, and the importance of finding means by which engineers could meet for the private interchange of knowledge and the discussion of those problems which are bound to arise in the change-over from peace-time to war-like activities. We repeat again that we do not believe that the disturbance of one of their most important functions will be tolerated for long by the technical institutions. The Councils of several of them have already signified their intention to re-consider the whole matter of meetings at the end of the year. One, at least, which had contemplated the total abandonment of its programme of meetings, has already modified the decision. It has been decided by the Council of the Institution of Mechanical Engineers that the Presidential Address and two important lectures shall be delivered, always providing that in the meanwhile hostilities do not take a more adverse turn. The question of holding meetings for the discussion of papers is also to be studied. Soon, we believe, many of the institutions will find it possible to work to a programme of meetings, modified and reduced perhaps, but substantially adequate to ensure a satisfactory interchange of knowledge.

# The Electricity Commissioners' Annual Report

IN issuing the nineteenth annual report covering the year April 1st, 1938, to March 31st, 1939, the Electricity Commissioners drew special attention to the section headed "Prices of Indirect Supplies in Bulk." For obvious reasons certain information which would normally have been given, *i.e.*, detailed particulars of new generating stations and sanctions for extensions during the year under review, has been omitted from the report, but the Commissioners will be prepared to consider publishing such particulars at a later date if they are regarded as likely to be of public interest.

The total output of electricity generated by authorised undertakers in 1938–39 amounted to 25,284 million units, showing an increase of 1938 million units or 8·3 per cent. on the figures for the previous year, notwithstanding the somewhat slow recovery from the decline in the rate of increase in the last quarter of 1937–38. In 1938–39 the rate of increase in output ranged between 5·7 and 6·9 per cent. during the first three quarters up to the end of 1938, but amounted to as much as 13·7 in the March quarter of 1939, thus reflecting the improvede mployment statistics during that quarter and the rising industrial demand.

The amount of new generating plant sanctioned by the Commissioners in 1938–39 for selected stations for meeting prospective demands on the grid system reached the substantial total of over 900,000 kW, this figure being inclusive of the plant required for the initial sections of two new selected stations. The actual aggregate capacity of plant sanctioned for new stations and extensions was 919,285 kW as compared with 659,455 kW in the preceding year and represented the second biggest amount sanctioned in any year since the establishment of the Electricity Commissioners in 1920. In a number of instances the installation of the new plant in existing stations involved the displacement therefrom of other generators of smaller size or of obsolete type.

Of the generating plant sanctioned during the past nineteen years approximately 57 per cent. was for stations belonging to Public Authority undertakings, about 36 per cent. for stations of company undertakers, and the remaining 7 per cent. for stations owned by railway and tramway authorities and non-statutory undertakings, some of the latter eventually becoming authorised undertakings.

Early in 1937 the Commissioners convened a National Committee of representatives of the electricity supply industry to assist them in reviewing problems of civil defence, in relation to electricity undertakings and the practical application of air raid precautionary measures to generating stations and electricity supply systems generally. From the outset the Commissioners acted in close consultation with the Air Raid Precautions Department of the Home Office. Following the announcement in 1937 that the Government had accepted the principle of a contribution towards expenditure on measures necessary to ensure continued functioning of essential public utility services in war time, the Commissioners in consultation with the National Committee and the principal associations of the electricity supply industry drew up a collective scheme which was approved and for which provision was made in the Civil Defence Bill introduced into the House of Commons in March, 1939.

With regard to precautionary measures appropriate to be taken by individual undertakings a memoranda prepared by the Air Raid Precautions Department of the Home Office in consultation with the Commissioners, and embodying the recommendations and suggestions, was issued by the Commissioners to all electricity undertakers. About the same time the Commissioners also issued to all electricity undertakers the report of a technical committee which had been appointed by them to consider the problem of fire risks and the mitigation thereof in generating stations and substations, this committee having advised as to the steps which could or should be taken to minimise fire risks and the nature of the fire-fighting equipment most suited to the varying circumstances of individual undertakings.

Failures of supply which occurred during the past year served to emphasise that all undertakers should adopt the fullest practicable measures against fire risks as an essential feature in the normal operation of their undertakings. On December 14th, 1938, a fire broke out at the generating station of the Corporation of Kingston-upon-Thames and resulted in serious damage to the generating station and in an extensive interruption of supplies, whilst on January 6th, 1939, a breakdown occurred on the transmission system between Preston and Blackpool, resulting in damage by fire to the generating station and in an extensive interruption of supplies to consumers at Blackpool, Lytham St. Annes, and Fleetwood. In each case the Commissioners appointed their Chief Engineering Inspector to inquire into and report on the cause of the breakdown, and by arrangement with the Home Office one of H.M. Electrical Inspectors of Factories sat with the Chief Engineering Inspector during each inquiry. The reports on the two inquiries have been published. Another failure of supply occurred at Great Yarmouth on March 20th, 1939, as the result of the bursting of two oil-filled reactors in the generating station, the accident also causing loss of life. The Commissioners were furnished by H.M. Senior Electrical Inspector of Factories with a detailed report on the matter, the salient feature which emerged being the importance of always having the protective gear on all circuits connected up and operating correctly.

The number of stations of authorised undertakers dealt with in this report is twenty-two less than in the previous year. This difference is attributable to the discontinuance of generation at twenty-one stations before January 1st, 1938, to the bringing into operation of one existing station which did not generate in the previous year, to the inclusion of two existing stations which became part of authorised undertakings during 1938, and to the substitution of combined particulars in four cases where sectional particulars were given in the previous year. These four cases related to selected generating stations built in sections in separate buildings, each station having previously been counted as a separate station.

The output (units generated by authorised undertakers during the calendar year 1938) showed an increase of over 1466 million units or 6·4 per cent. on the figure for 1937. The larger output was accompanied by an increase of 155,350 tons or 1·1 per cent. in the amount of coal and coke consumed. Public authority undertakers accounted for an increase of 814 million units, and company undertakers for an increase of 652 million units. The steam power stations of authorised undertakers included in the returns accounted for 95·25 per cent. of the total units generated, and the average number of units generated per ton of coal and coke consumed in such stations amounted to 1640 units. The effect of the progressive improvements in steam power station practice which have taken place in the stations of authorised undertakers during the past eight years is shown by the fact that the average number of units generated per ton of coal and coke consumed has increased from 1200 units in 1930 to 1640 units in 1938, *i.e.*, by over 36 per cent. The sales of electricity by authorised undertakers in 1938 showed an increase of over 1333 million units or about 7 per cent. as compared with the figure for 1937. On the basis of the estimated population of Great Britain in 1938, namely, 46·2 million inhabitants, the sale of electricity from public sources of supply in that year represented an average consumption of approximately 441 units per head of population.

During the year 1938–39 the Commissioners issued thirty-nine consents to the establishment or extensions of main transmission lines by the Central Electricity Board and other authorised undertakers. The consents issued to the Central Board covered the construction of about 148 miles of primary grid lines at 132 kV and about 17 miles of grid lines at 66 kV or a total of approximately 165 miles, and also certain other transmission lines of lower voltage. The consents issued to other authorised undertakers covered the construction of 58 miles of 66 kV lines, 120 miles of 33 kV lines, 24 miles of 25 kV lines, 7 miles of 22 kV lines, and 10 miles of 11 kV lines.

# The Murdock Centenary

THE centenary of the death of William Murdock (1754–1839) * was commemorated by the Institution of Gas Engineers very appropriately, because he was the founder of their industry, by holding a meeting, largely attended, on June 6th last, at which Dr. E. F. Armstrong, F.R.S., delivered the Murdock Centenary Lecture; this resolved itself as one might expect from such a milieu into a historical review of the rise and progress of the gas lighting industry rather than into a study of Murdock himself to whom, as a matter of fact, only about one-tenth of the lecture was devoted. Murdock will be remembered for all time in this connection and rightly so; it is a tragedy that his centenary should coincide with the black-out.

Gas lighting was far from being even a major activity of his life. Starting with experimental work in his house at Redruth about 1792, he went on to the illumination of Soho Manufactory in 1802 to celebrate the peace of Amiens, to lighting the principal workshops of Soho Foundry from 1803 onwards, to lighting of the cotton mill of Phillips and Lee in Manchester, where he eliminated the "Soho stink" until about 1808, when he relegated farther development to the hands of others, like his pupil, Samuel Clegg, who more

* It is the fashion now to spell his name Murdoch; that certainly was his patronymic, but finding the degenerate Sassenach unable to master the guttural final syllable he gave way, and he and his descendants have used the spelling above.

than anyone else placed the gas industry on a sound engineering foundation.

For us, it is as a great mechanical engineer, as an indefatigable practical, resourceful, and inventive man, as a staunch and devoted assistant to both Watt and Boulton of Soho, Birmingham, as one of the class who, desiring neither fame nor riches, are content to serve others, that we remember William Murdock. Wherever we find a big man in the limelight, a *fidus Achates* will nearly always be found in the background; such was Murdock.

John Murdock, his father, was a farmer, a miller, and a millwright, and in this environment the boy was brought up. When 23 years of age, like so many Scotsmen before and since, he set his face southwards and directed his steps—literally it is said—to Soho Manufactory, then in the height of its fame and already beginning the manufacture of Watt's patent separate condenser steam engine. It was fortunate that when he arrived there he was able to see Boulton, for Watt had a prejudice against his countrymen, although they were steadier and quite as able as their English brethren. The tale has been told over and over again how Murdock, feeling nervous during his interview with the great man, kept twiddling his hat which Boulton, intrigued by the look of it, elicited from Murdock that it was made of wood on a lathe of his own contrivance; this must have been in the nature of an oval lathe, and even if he had got the idea from elsewhere, the construction of such an accessory showed him to be a born mechanic. He was engaged almost at once, at the moderate wage of 15s. a week, and after a couple of years erecting engines up and down the country he was sent in 1779 into Cornwall, where the firm was in the thick of erecting engines on the Cornish mines. Here he rapidly became the right-hand man. He was a man of great physical strength and got on excellently with the Cornish men, for he was quite as ready with his "dukes" as they were. For two decades Cornwall was his home, there he married Ann Paynter, daughter of a mine captain, there his children, two sons and two daughters, were born, and there his wife died.

That he "toiled terribly" is evidenced over and over again in the Boulton-Watt correspondence. For instance, in 1782 Boulton writes: "Murdock hath been indefatigable ever since they began (*i.e.* erecting the engine on Consolidated Mines), he has scarcely been in bed or taken necessary food for everyone seems helpless in comparison of him." Boulton goes on to tell how Murdock had "been slaved" for about 60 hours without getting to bed till 4 a.m. and then being up again at 10 a.m. in Poldice cistern "searching for pins and cotters that had jumped out."

On another occasion in 1784 Boulton wrote: "We want more Murdocks for of all others he is the most active man and best engine erector I ever saw." On this occasion, we learn that "he hath not gone to bed for 3 of the nights."

He did not spend all his time on the erection and maintenance of engines. Many were the schemes that matured in his brain: piston packing, a hot-air engine, a hydraulic engine, an oscillating steam engine, an air-lift pump, but they did not get far past the experimental stage. There were other schemes, however, that had very practical applications, such as the sun and planet gear, 1782, which, substituted for the crank in Watt's rotative engine till Pickard's patent for the application of a crank to a steam engine had expired, seems to have owed more to Murdock than to Watt. The invention of iron cement was just such another case.

The big obsession of Murdock was the steam carriage to go on common roads. As early as 1784, Boulton wrote Watt to say that he had "had a little conversation with Brown (that was the partners' pseudonym for him) about wheel carr$^{s}$" and goes on to give the gist of what Murdock proposed. "I verily believe he would sooner give up all his Cornish business and interest than be deprived of carrying the thing into execution." Dissuaded by the partners for the time being, the scheme seethed in his mind. Then occurred the dramatic meeting of Boulton with Murdock at Exeter; the latter stated that "he was going to London to get men, but I soon found he was going there with his steam carriage . . . to take out a patent. However, I prevailed upon him to return to Cornwall by the next day's diligence and he accordingly arrived here (*i.e.* Redruth) this day at noon since which he hath unpack'd his carriage and made it travil a mile or two in Rivers's great room making it carry the fire shovel, poker and tongs. I think it fortunate I met him as I am persuaded I can either cure him of the disorder or turn the evil to good." Altogether he made two or three models of steam carriages. It was perhaps as well that he was cured of his disorder because, if subsequent experience is any guide, it would have taken years and years of work to have solved the problem satisfactorily.

When in 1798 Watt's patent was about to expire and the burst of engine building was over, Murdock, despite tempting offers to stay in Cornwall, returned to Soho. Here he got busy with the lay-out of Soho Foundry, the erection of which had just begun, and particularly with the construction of new machine tools, especially the boring mill. Then ensued a period of great mental activity. In 1799, he patented among other improvements in the steam engine the long D slide valve. About 1800 he brought out the "eccentric circle" and strap for actuating a slide valve. In 1810 he patented a method of boring stone pipes for water supply; these were used in the Manchester Waterworks and some can still be seen serving as flowerpots in the Manchester parks. A cherished scheme was the employment of compressed air obtained from the blower of the foundry cupola to drive a small motor geared to a lathe, and he extended its use to a pneumatic lift in the foundry. In fact, he was never so happy as when he was inventing and scheming.

The young partners of Boulton, Watt and Co., who took over from their fathers in 1800, greatly looked up to Murdock, who was the presiding mechanical genius of the place. From that date onwards he received a salary of £300 a year and commission on gas apparatus sold; in 1810 he received £1000 a year till he retired in 1830. In 1816 he built himself a house at Sycamore Hill, now alas gone, within sight of the Foundry, and fitted it, as one might expect, with gadgets such as pneumatic bells and a gas supply for lighting through pipes from the Foundry. The grand old man died at his home on November 15th, 1839, at the ripe age of 85 years, and was buried near Boulton and Watt in Handsworth Parish Church.

We are glad to know that the actual date of the centenary has been suitably marked. We may mention a memorial lecture before the Royal Cornwall Polytechnic Society at Falmouth by Mr. W. T. Hooper on the day itself, a meeting at Murdock House, Redruth, on Saturday November 18th, and a chaplet placed by the Newcomen Society under the bust of Murdock by Chantrey in the chancel of Handsworth Church.

## Obituary

### ROBERT DUMAS

MR. ROBERT DUMAS was known to a great number of engineers and the news of his death on November 20th, at his home in Leamington Spa, will be received with real sorrow. Until last June he was a prominent member of The British Thomson-Houston Company's staff with whom he had served for 31 years; but his activities did not end in the service of his company, and in particular the part he played in the work of the British Standards Institution will never be forgotten.

Mr. Dumas, who was born in 1865 at Weldon, Bucks, was educated at Bristol Grammar School and Anderson College, Glasgow, and served his apprenticeship with the Fairfield Shipbuilding Company. He was Mechanical Superintendent at the Stafford Works of Siemens Bros. and Co., Ltd., till 1903; then Works Manager for The General Electric Company, Ltd., Witton, till 1906; and then Works Manager for Bruce Peebles and Co., Ltd., Edinburgh, till 1908. The experience he accumulated in those early days, together with his extraordinary knowledge of engineering matters, placed him in the front rank of mechanical engineers.

He joined the B.T.H. Company in May, 1908, as Manager of the Rugby Works, but after 1929 acted in a consultative capacity. His love of work and his untiring energy, coupled with a pleasant personality and human understanding, made him a natural leader of men; and the freedom from labour troubles which the company enjoyed under his guidance was a tribute to his fairness in dealing with labour problems.

Among the "milestones" of his B.T.H. career may be mentioned his work on a rational system of limits which has since been adopted by many firms in the industry, the institution of a measuring room with well-kept accurate standards, and the development of a scientific and practical method of commutator building vastly superior to previous rather haphazard methods.

Perhaps his greatest attribute was his ability and readiness to help those who sought his advice; and many of the B.T.H. Company's engineering advances resulted from this helpful co-operation.

ROBERT DUMAS

His colleagues knew him as a man of strong character and exceptional qualifications.

He was a Whitworth Exhibitioner and a Member of the Institution of Mechanical Engineers.

## Sixty Years Ago

### HENRY CRAWSHAY

ON November 24th, 1879, Mr. Henry Crawshay, aged seventy-six, died at his seat, The Oaklands, near Newnham. He was the third son of William Crawshay, the "Iron King of Cyfarthfa." He and his brothers, Robert and Francis, all died within a space of eighteen months. The Crawshay family first became associated with the Welsh iron industry about the year 1835 when William became the possessor of some works near Cinderford in the Forest of Dean. Ironmaking in the Forest dated from Roman days, the primitive material then made being sent over to Bristol to be fashioned into swords and other implements. The Roman process of recovering iron from the rich hematite ores of the district was very wasteful, the metal recovered not exceeding 10 to 15 per cent. of the total content. They left great stores of cinders behind them. The existence of these cinders gave Cinderford its name and in a later age called the attention of speculators to the rich deposits of ore in the district. William Crawshay developed the business which he had acquired with great energy. Soon he began purchasing other properties at Buckfast, Lightmoor, and elsewhere. On his death he left his works at Cyfarthfa to his son Robert, Treforest and Hirwain to Francis, and the Forest of Dean property to Henry. From an early age, Henry after his return from Harrow, had been educated in ironmaking and after being given the management of Hirwain was transferred to the Forest of Dean works. He had all his father's perseverance and intuitive power. He was rugged in manner, generous hearted, and of unswerving probity. He worked strenuously to improve his inheritance and until the iron trade began to decay on the advent of steel great prosperity attended his labours. He held firmly to the traditions of the Crawshay family and disliked the banding of capital as much as the organisation of labour in unions. Masters and men, he contended, should work together in faithful regard of each other's interests and should help one another. His beliefs on this subject were put to a test on one occasion when a great strike broke out among the colliers of the neighbourhood. He refused to join the association of masters and published a letter vindicating his course of action. In his opinion no reduction of wages was called for and he pleaded that the colliers "should be allowed to have bright hearths and joyous hearts at the coming Christmas time as well as anybody else." In our issue of November 28th, 1879, we said of him that he was unmistakably one of the old school—vigorous in action, just in deed, and brimful of human sympathies.

# Technical Institutions in War Time

ONE effect of the war has been to restrict, alter, and otherwise to interfere with the activities of the engineering technical institutions. We therefore, print below in short summary some particulars of the policies being followed by a number of the Institutions.

*Education.*—In a number of matters the Institutions have, by common consent or independently, decided to follow similar policies. Notably is this the case among those institutions concerned with education. All those institutions which hold examinations, and award certificates and diplomas are endeavouring to maintain their organisations so that facilities for the education of young engineers will be interfered with as little as possible.

*Research.*—Some interference with the research activities of the institutions is inevitable, not only because the controlling Committee members may have more urgent calls upon their services, and the research staffs be depleted, but also because under war-time conditions co-operation with firms working on the supply of urgent war-time materials becomes more difficult however great the goodwill on both sides. Work has thus become concentrated upon those researches which obviously have a direct bearing on the needs of industry in war time, and there has been a corresponding slackening of research of a more academic nature. Every institution which has research equipment available has signified its readiness to investigate problems of urgent importance.

*Co-operation with Government Departments.*—All institutions are co-operating in every possible way with those government departments interested in their particular branches of engineering, and more particularly with the Ministry of Labour and National Service in compiling and making use of the "National Register." It will be recalled that in September, 1938, the Institutions, at very short notice made registers of the scientific and technical qualifications of their members. The Ministry of Labour and National Service subsequently made use of this material in building up the "National Register" which is becoming the main channel through which appointments are made. The Institutions are represented in the Central Advisory Council to the Ministry by a General Engineering Committee which has appointed Sub-Committees to deal with the different branches of engineering. A very large number of demands from the Ministry of Supply, the War Office, the Admiralty, the Air Ministry, and other government departments together with some from private firms have been met.

*Meetings, Social Events, &c.*—The greater number of Institutions have cancelled all or nearly all their meetings of whatever kind. But several are carrying on in one way or another, and we give below particulars of their activities. Certain institutions have removed parts of their staffs to country addresses. When this is the case the address of the Headquarters' building is given in addition to that of the Secretary.

### Engineers Guild

Secretary's Address :—c/o Midland Bank, Ltd., 1, Central Buildings, Westminster, S.W.1. A meeting of the new Council has not yet been held and no definite decision regarding war-time activities has yet been made.

### Institute of British Foundrymen

Secretary's Address :—St. John St. Chambers, Deansgate, Manchester, 3.

Meetings, &c :—At the outbreak of war all branches were requested to continue their winter programmes as far as possible. Meetings so far held have been well-attended. The following branches have already held meetings or are about to hold them : Birmingham, Lancashire, Burnley, Middlesbrough, Scottish, Falkirk, West Riding of Yorkshire, Wales and Monmouth. The East Midlands and London branches held experimental meetings recently. The East Anglian and Bristol sections have suspended all meetings. The Newcastle branch hopes to arrange for two or three meetings in the spring, and the Sheffield branch is to re-consider the suspension of meetings at the end of the year, and is endeavouring to obtain papers for publication.

### Institute of Fuel

Secretary's Address :—30, Bramham Gardens, London, S.W.5.

Meetings, &c. :—London meetings are being held periodically for the reading and discussion of papers, but owing to the "black-out" they are held in the early afternoon. The number of meetings will be reduced. Meetings have already been held in London and Bristol. It is intended that other branches at Manchester, Newcastle, Derby, and Nottingham shall also hold them. The Journal will continue to be issued regularly.

### Institute of Marine Engineers

Secretary's Address :—73, Amersham Road, High Wycombe, Bucks.

Headquarters :—The Institute's London premises, 85/88, The Minories, E.C.3, remain open from 10 a.m. to 7 p.m. for members requiring to use the reading-room and library.

Meetings, &c. :—The entire programme of meetings, social events, and visits has been cancelled. Papers to have been read will be published in the "Transactions," in which will also appear the usual technical abstracts.

### Institute of Metals

Secretary's Address :—4, Grosvenor Gardens, London, S.W.1.

Headquarters :—Library and information facilities are available. Arrangements have been made to transfer the office to a country address only if rendered necessary.

Meetings, &c. :—Original papers will be published in the monthly Journal, together with technical abstracts.

### Institute of Welding

Secretary's Address :—2, Buckingham Palace Gardens, Buckingham Palace Road, London, S.W.1.

Headquarters :—Headquarters' building remains open and the information service is maintained.

Meetings, &c.—The lecture programme has been curtailed. It is hoped to hold some meetings in London and at the branches. Papers to have been read will be published in the "Transactions," "The Welding Industry," or otherwise circulated. "The Welding Literature Review" will continue to be published.

Other Activities :—A scheme is being worked out for training welding supervisors and operators. A scheme has been prepared with the authority of the Government for organising the facilities of welding contractors for the repair by welding of structures damaged by air bombardment.

### Institution of Automobile Engineers

Secretary's Address :—12, Hobart Place, London, S.W.1.

Headquarters :—London headquarters will remain open as long as conditions permit, and all usual facilities will be available.

Meetings, &c. :—All London meetings are cancelled. Meetings of an informal nature may be held in provincial centres. Graduates continue to hold Meetings. Papers to have been read will be published in the Journal.

Other Activities :—Practical tests for I.A.E. repair certificates have been suspended for the duration of the war.

### Institution of Chemical Engineers

Secretary's Address :—56, Victoria Street, Westminster, London, S.W.1.

Headquarters :—Facilities at headquarters available as usual from 10 a.m. to 4 p.m. Monday to Friday.

Meetings, &c. :—No ordinary meetings are being held. Papers to have been read will be published in the "Transactions" together with written discussion. Graduates' meetings suspended.

### Institution of Civil Engineers

Secretary's Address :—Great George Street, Westminster, London, S.W.1.

Headquarters :—Reading-room and library are open as usual during daylight hours.

Meetings, &c. :—All meetings are suspended except such as are necessary for the transaction of business. The Conference on Engineering Education and Training and the Road Engineering Exhibition, both due to have been held early next year, have been postponed indefinitely. Papers to have been read at meetings will be published in the Journal for written discussion. Local Associations are considering the possibility of holding meetings.

### Institution of Electrical Engineers

Secretary's Address :—Savoy Place, Victoria Embankment, London, W.C.2.

Headquarters :—The library and reading-room are open 7½ h. each day, but the time of closing is influenced by the black-out. It was 5 p.m. until November 18th, and 4.30 p.m. subsequently.

Meetings, &c. :—All London meetings are cancelled except for the transaction of routine business. Meetings have been cancelled in most local centres. Papers will be published in the Journal with written discussions. Towards the end of the year policy is to be reviewed, and it is hoped to arrange a skeleton programme of meetings.

### Institution of Engineers and Shipbuilders in Scotland

Secretary's Address :—39, Elmbank Crescent, Glasgow.

Headquarters :—The library and reading-rooms are open daily. The former closes at 8.30 p.m. on Tuesdays, 5 p.m. on other weekdays, and 1 p.m. on Saturdays.

Meetings, &c. :—Meetings are being held monthly, dates being chosen near time of full moon. They are held at 6.30 p.m. Students' meetings are suspended.

### Institution of Gas Engineers

Secretary's Address :—1, Grosvenor Place, London, S.W.1.

Meetings, &c. :—The 11th Autumn Research Meeting fixed for November 21st and 22nd was cancelled.

### Institution of Heating and Ventilating Engineers

Secretary's Address :—22, Russell Square, London, W.C.1.

Meetings, &c. :—London meetings for the session have been cancelled. Branches are free to make independent arrangements. The Journal will be published monthly for 6 months. Publication thereafter is to be re-considered.

### Institution of Engineering Inspection

Secretary's Address :—5, Pierrepont Street, Bath.

Headquarters :—52, Grosvenor Gardens, S.W.1.

Meetings :—All evening meetings are suspended but luncheon meetings are to be organised. Papers will be circulated to members and discussed at luncheon meetings. The Journal is issued quarterly.

### Institution of Locomotive Engineers

Secretary's Address :—28, Victoria Street, Westminster, London, S.W.1.

Headquarters :—The usual facilities are available at headquarters.

Meetings, &c. :—Most of the general meetings have been cancelled. The Journal will be published as usual at bi-monthly intervals.

### Institution of Mechanical Engineers

Secretary's Address :—The Meadows, Betchworth, Surrey.

Headquarters :—Storeys Gate, St. James Park, London, S.W.1. Library and reading-rooms are open between 9.30 a.m. and 5.30 p.m. daily.

Meetings, &c. :—General programme has been cancelled. Thomas Hawksley and Thomas Lowe Gray lectures are to be delivered on January 19th, 1940, and towards the end of March respectively. Presidential address will be delivered on February 16th, 1940. These meetings will be held in the afternoon. Possibility of holding other meetings is to be reviewed, but none will be held before the Annual General Meeting on February 16th. Papers will be published in the Journal for written discussion, including those to have been read at the abandoned Summer Meeting in America.

### Institution of Mining Engineers

Secretary's Address :—Salisbury House, Finsbury Circus, London, E.C.2.

Meetings, &c. :—Meetings of the Federated Institutes are to be held if possible, and the usual publications will be issued.

### Institution of Mining and Metallurgy

Secretary's Address :—Salisbury House, Finsbury Circus, London, E.C.2.

Headquarters :—The usual facilities are available at headquarters.

Meetings, &c. :—General meetings are being held as much in accordance with the programme as possible, but in the afternoon instead of the evening. The Bulletin continues to be issued.

### Institution of Naval Architects

Secretary's Address :—10, Upper Belgrave Street, London, S.W.1.

Headquarters :—Usual facilities are available. The library is open from 10 a.m. to 4 p.m.

Meetings, &c. :—All meetings are cancelled. At the Annual General Meeting on March 13th only formal business will be transacted. Advance copies of papers will probably be available in the spring for written discussion before publication in the Transactions.

### Institution of Structural Engineers

Secretary's Address :—10, Upper Belgrave Street, London, S.W.1.

Headquarters :—Library and members' room are open from 9.30 a.m. to 5 p.m. daily ; 1 p.m. on Saturdays.

Meetings, &c. :—Ordinary General and Informal Meetings are being held. During October and November publication of "The Structural Engineer" ceased. Arrangements have now been made to ensure the normal issue of this publication.

### Iron and Steel Institute

Secretary's Address :—4, Grosvenor Gardens, London, S.W.1.

Headquarters :—Library and information departments are available for consultation by members.

Meetings :—The September meeting at Cardiff having been cancelled a "statutory" meeting for the transaction of formal business only was held at the Institute on November 23rd. It is hoped to arrange for the presentation of papers at the Annual General Meeting in the spring. All other meetings have been deferred. Two volumes of the Journal dealing with the present year will be issued, but arrangements regarding later volumes are not yet settled. The Bulletin will be published monthly as usual.

### Junior Institution of Engineers

Secretary's Address :—39, Victoria Street, Westminster, S.W.1.

Headquarters :—Library and reading-room open as usual.

Meetings, &c. :—Originally decided to hold one meeting per month. Success of first meeting was so marked that two meetings per month are now being held. The Journal is being issued as usual.

### Liverpool Engineering Society

Meetings, &c. :—All meetings have been cancelled. Papers will be published in monthly Bulletin and papers and written discussions will be printed in the Transactions.

### Manchester Association of Engineers

Secretary's Address :—St. John Street Chambers, Deansgate, Manchester, 3.

Meetings, &c. :—All meetings have been cancelled. Advance copies of papers are to be circulated for written discussion, and the whole will be printed in the Transactions.

### Newcomen Society

Secretary's Address :—Barn Field, Riddlesdown Road, Purley, Surrey.

Meetings :—In the New Year it is intended to hold Meetings in the afternoon, on the dates already given in the 1939–40 programme. The papers, as announced, will be presented at these meetings.

### North-East Coast Institution of Engineers and Shipbuilders

Secretary's Address :—Bolbec Hall, Newcastle-upon-Tyne, 1.

Headquarters :—Library and reading-room open as usual daily and on Wednesdays and Saturdays until 9 p.m. (temporarily 8 p.m. at present).

Meetings, &c. :—Meetings are being held as usual, but the time has been altered from 6 p.m. to 5.30 p.m., and the length of the meetings is reduced.

**Royal Aeronautical Society**

Secretary's Address :—Brook House, Old School Lane, Brockham, Surrey.
Headquarters :—4, Hamilton Place, Piccadilly, London, W.1. Open Monday to Friday. The office closes not later than one clear hour before the "black-out" begins.
Meetings, &c. :—Lectures have all been postponed. A resumption will be made as early as possible. The Air Conference to have been held at Stratford-on-Avon in 1940 has been postponed. The Journal will continue to be published monthly.

**Royal Society of Arts**

Secretary's Address :—c/o Basil Ionides, Esq., Buxted Park, Sussex.
Headquarters :—John Street, Adelphi, London, W.C.2. Library remains open.
Meetings :—Meetings are being held as usual except that they take place in the afternoon instead of the evening. Publication of the Journal continues normally.

**Royal Institution**

Secretary's Address :—21, Albemarle Street, W.1.
Meetings :—Meetings are being held in the afternoon or early evening.

**Sheffield Metallurgical Association**

Secretary's Address :—93, Hallowes Lane, Dronfield, nr. Sheffield.
Meetings, &c. :—The lecture programme is being carried out normally.

**South Wales Institute of Engineers**

Secretary's Address :—Park Place, Cardiff.
Meetings, &c. :—Meetings are being held according to programme, but commence at 3 p.m. instead of 6 p.m. The Conversazione at the National Museum of Wales, Cardiff, due to take place on September 21st, was cancelled, and the Engineering Exhibition at the Treforest Trading Estate (November 8th–18th, 1939) was also cancelled.

## Germany's Vulnerability*

FIFTY per cent. of the total industrial output of Germany, 57 per cent. of the heavy industry, and 57 per cent. of the output for export, are produced within 150 miles—less than an hour's flight—of the west front, and an additional 3–4 per cent. of each total within 50 miles of the north-west coast. A further indication of the extreme geographical vulnerability of German industry is the fact that nearly a fifth of the total output is produced on the left of the Rhine.

The new developments in central Germany are a significant addition to German productive capacity in the heavy industries, but do not yet represent any appreciable transfer from the west.

Germany, then, is in a very vulnerable position in any intensive air warfare. Half her industry and more than half of her heavy armament industry is within very easy range of bombers based on aerodromes in Lorraine. A direct comparison between the vulnerability of Great Britain and Germany is not statistically possible, for the simple reason that while hostile bombers can be, and are, based within a mile or two of the German frontier, there are no hostile bases within 240 miles, at the very nearest, of the English coast. The nearest British industrial area of any consequence to the German coast is Lincolnshire, which is 300 miles from the Frisian Islands. A round trip of 600 to 800 miles over the North Sea is not, of course, an obstacle comparable to the same distance flown over watchful and well-defended hostile territory. But it does mean that more fuel must be carried, and therefore fewer bombs, that warning of approach may be given much sooner, and that there is a greater chance of casualties on the way out or the return journey. Possibly, most important of all, it means that bombers cannot be convoyed by fighters.

To arrange British industry in similar belts, measuring from the East Coast, would, therefore, run the risk of making British industry seem more vulnerable than in fact it is. For example, something like a third of the whole industry of the country and a little more than a quarter of its armament industry (in 1935) is in Greater London, the Eastern district, and the North-East Coast—that is, less than 50 miles from the coast; only about 10 per cent. of all industry and about the same proportion of armament industry is more than 150 miles from the east coast. But if we reckon one mile over the sea as being the equivalent of only one-third of a mile over hostile land, even London is 150 "hostile miles" from the nearest German base—*i.e.* at the extreme edge of a radius that includes more than half of German industry. Detailed figures have, therefore, not been given for Great Britain similar to those contained in the table for Germany. But a rough comparison can be made as follows. Nearly half of total German industrial output, and distinctly more than half of heavy industry and export industry is within a total area of about 30 million acres (leaving out of account the thinly industrialised Hanover and Bavaria) not more than 150 miles from the French frontier. On the other hand, a penetration of 100 miles into England, on top of 250 to 400 miles over the North Sea (*i.e.* a range of 100 to 230 "hostile miles" on the rough basis of three sea miles=one land mile) would be required to cover a little over half of total British industry and a little less than half of heavy industry. This British industrial area, however, is more concentrated, comprising about 20 million acres.

These facts may possibly explain why, in spite of the boasted superiority of the Nazi air fleet, Goering has hitherto been too "humane" to use it.

| | Percentage of German Net Output | | | Net Output per acre |
|---|---|---|---|---|
| | Total Industry | Heavy and Armament Industry | Export Industry | |
| | | | | Rm. |
| *Less than 50 miles—* | | | | |
| *from West Front—* | | | | |
| Saar ... ... ... | 1·3 | 2·0 | 1·7 | 965 |
| Palatinate ... ... | 1·6 | 1·6 | 2·5 | 402 |
| Baden ... ... ... | 3·7 | 3·3 | 4·1 | 338 |
| *from N.W. Coast—* | | | | |
| Oldenburg ... ... | 0·4 | 0·3 | 0·3 | 99 |
| Hamburg ... ... | 1·6 | 1·5 | 2·0 | 3160 |
| Schleswig-Holstein | 2·0 | 1·5 | 1·3 | 175 |
| Total .. ... | 10·6 | 10·2 | 11·9 | 330 |
| 50–100 *miles—* | | | | |
| *from West Front—* | | | | |
| Hessen ... ... ... | 1·9 | 1·9 | 2·8 | 334 |
| Hesse-Nassau ... | 3·3 | 3·9 | 5·0 | 273 |
| Württemberg, Hohenzollern ... | 5·5 | 5·0 | 4·9 | 369 |
| Total .. ... | 10·7 | 10·8 | 12·7 | 328 |
| 100–150 *miles—* | | | | |
| *from West Front—* | | | | |
| Rhineland ... ... | 15·1 | 19·3 | 20·9 | 856 |
| Westphalia ... ... | 9·7 | 13·2 | 11·3 | 665 |
| Hanover ... ... | 4·5 | 4·1 | 3·6 | 161 |
| Bavaria (half) ... | 3·8 | 2·3 | 0·3 | .. |
| Total ... ... | 33·1 | 38·9 | 36·1 | 481 |

* Extract from an Article in *The Economist*, November 18th, 1939.

## The Iron and Steel Institute

THE Statutory Autumn Meeting of the Iron and Steel Institute, which, but for the war, would have been held in Cardiff on September 12th to 15th, was held on Thursday, November 23rd, 1939, at 3.30 p.m., at the offices of the Institute, 4, Grosvenor Gardens, London, S.W.1. In the unavoidable absence of the President, Lord Dudley, Mr. James Henderson, Vice-President, was voted into the Chair.

The Chairman said the work of the Institute was continuing, and the offices at 4, Grosvenor Gardens remained open for the use of members. Some change in the activities of the Institute, especially with regard to meetings and publications, had been necessitated by the war. He announced that Mr. John Craig (Vice-President), had accepted the Council's invitation to become President of the Institute for two years from the Annual Meeting, 1940.

The membership of the Institute had been well maintained; figures would be published in the Spring as usual. There seemed to be no reason to expect a serious fall in numbers during the war, since it was hoped that new applicants connected with the industry in this country would outbalance any falling off in foreign membership. Some diminution in foreign membership was probably unavoidable, especially as currency restrictions made it difficult to transmit subscriptions. The Council had made reasonable provision for this contingency in framing the financial estimates. In accordance with Bye-law No. 36, the membership of German nationals lapsed on the outbreak of war. The ballot list contained the names of well over a hundred candidates for Membership and Associate Membership.

As a result of the appeal which the President issued in May, contributions of £13,033 8s. had been received to the House Fund, and annual subscriptions of £3,315 2s. had been promised from companies. Most of the leading companies in the industry had subscribed, and, on behalf of the Council, he wished to thank them for their generosity.

At the same time, the Council wished him to point out that there was still a very large number of companies from whom no contribution had been received. There was always a tendency for central organisations, and perhaps particularly research organisations, to be financed mainly by a limited number of companies, but he ventured to suggest that the work of the Institute was of importance to all who were engaged in the manufacture of iron and steel, as well as to many who were re-rollers and manufacturers of steel products. He hoped that those companies also would subscribe, and he would ask members of the Institute who were connected with companies to draw their attention to the President's appeal and to endeavour to ensure that it obtained the support of all members of the Federation and all companies connected with the industry.

The Joint Committees of the Institute and of the British Iron and Steel Federation, which were part of the organisation of the Iron and Steel Industrial Research Council, were continuing their work.

Owing to the outbreak of war, the Autumn Meeting, which was to have been held at Cardiff from September 12th to 15th, had to be cancelled. The fact that Autumn Meetings had been cancelled in two successive years was a measure of the troubled times in which we lived.

Arrangements for meetings next year had not yet been completed. The Annual Meeting would be held as usual, probably in London, at a date to be arranged, and it was proposed to hold meetings in the main centres of production, in order to give ample opportunity for technical discussion. It was hoped also to continue holding joint meetings with local societies, as had been the practice of the Institute in the past. A number of local societies were continuing their normal arrangements and, whatever might be possible in London, it was thought that it would be of material assistance to the industry if institutions in the provinces continued to hold meetings.

The Symposium on Blast Furnace Practice which was to have been held during the Annual Meeting next year had been postponed. It was hoped that Mr. Clements and his Committee would resume their work immediately the war was over.

The Joint Library of the Iron and Steel Institute and the Institute of Metals was continuing its usual activities and was, he was glad to say, being widely used by members of both Institutes.

The Council would continue the award of prizes for suitable papers. For a number of years the Williams Prize, usually to the value of £100, had been awarded to the author of a paper of practical interest, and Captain Ablett had generously promised to renew his prize of £50 for a paper on steelworks engineering written by a junior engineer. The Council hoped that candidates would submit papers as usual; papers should be received before the end of January. Carnegie Scholarships of £100 would be awarded as usual.

The Secretary announced that the following Carnegie Scholarships had been awarded :—

F. L. Gillemot, Technological Institute, Budapest, Hungary, £100 in aid of a research on the influence of the base material and manufacturing procedure on the fatigue of wire ropes.

T. P. Hoar, Metallurgical Laboratories, Cambridge University, £100 for a study of the conditions leading to intensive corrosion.

A. Latin, Department of Metallurgy, Manchester University, £100 for a critical review of existing knowledge concerning the structure of ingots.

G. Parker, the University, Leeds, £100 in aid of a research on the oxidation and scaling of steel.

The Chairman, in closing the meeting, said it must have established a record for brevity. He thanked the members for their attendance, and said it was desired to emphasise that the activities of the Institute would be carried on to the fullest possible extent. It must be appreciated, he added, that, while dates were being put down for meetings next year, these must be to some extent at any rate of a provisional character, and circumstances might arise which would make it difficult for the dates to be adhered to. With that proviso, however, the Institute would be glad if the fullest publicity could be given to its intention to carry on its activities, which were regarded as no less important to-day than in pre-war times, and if anything as more important.

## Letters to the Editor

*(We do not hold ourselves responsible for the opinions of our correspondents)*

### THE SMALL MANUFACTURER

SIR,—No doubt your many readers have been interested in the correspondence appearing in the National Press from the Small Manufacturers who are unable to obtain orders for their materials from the Ministry of Supplies, or from the War Office Contracts Department or the Air Ministry.

I am one of these unfortunate makers, who, like others, finds that owing to the war his business has practically ceased.

I am sure that the remedy to this position lies with us. Had we been an organised body we would have received consideration, and I suggest that a meeting be called immediately, to be held in London, so that a representative committee of all industries may be formed, acting on behalf of the Small Manufacturer.

It is only through "unity" we shall save our businesses, and if the war continues for long the Government will require us. It is up to us to be ready and organise ourselves so that we may carry on in the meantime.

Will any of your readers who are interested write to me, and I will be only too willing to proceed with arrangements for this meeting.

J. A. R. MCDONALD.

30/40, Dalling Road,
Hammersmith, W.6.
November 18th, 1939.

# Concrete for Hydraulic Structures

By G. S. LALIN, Stockholm

No. II

(*Continued from page 528, Nov. 24th*)

THE diagram, Fig. 11, shows the relation between the cement content, the maximum size of the stone, the proportion of sand to stone, and the water-cement ratio for a workable mixture. The advantages of using large stones is obvious; the water-cement ratio goes down and the quantity of stone can be increased without the workability being impaired. But obviously the size of stones cannot be increased to an unlimited extent. It is dependent to a certain degree on the size of the mixer. At the works carried out by the Board of Waterfalls it has been found that a mixer of 1 cubic metre capacity is suitable for 120 mm. stone, whilst a mixer of ½ cubic metre capacity is sufficient for 60 mm. stone.

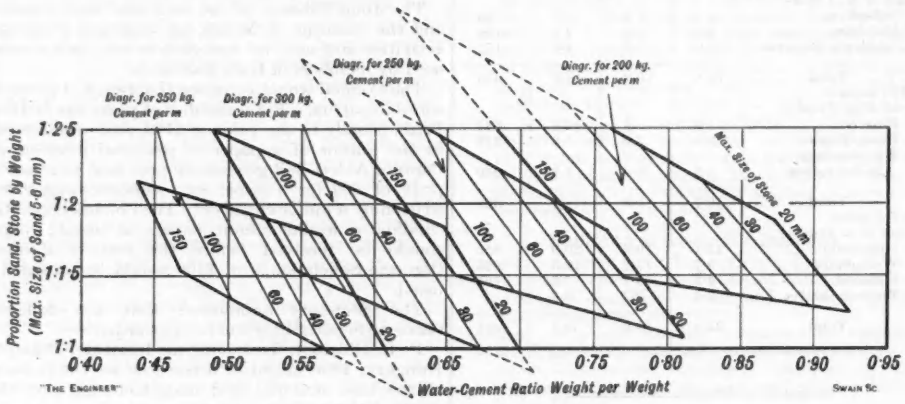



FIG. 11—RELATION OF VARIOUS FACTORS FOR WORKABLE MIX

Fig. 12 shows the surfaces of sawn pieces of a pair of test specimens from Stadsforsen. The largest stones are approximately 120 mm. Despite the size of the stones, their distribution in a concrete with relatively high cement content is fairly even and the stones are as a rule well surrounded by mortar. The illustrations show that a careful gradation is a factor appreciably more important for lean concrete than for concrete with high cement content.

To obtain a uniform concrete mass and a homogeneous concrete in the first place such selection of concrete materials and the proportions are required as will give good workability and such plasticity that the materials do not separate during the conveyance from the mixer to the forms. Many attempts have been made to measure the workability of a concrete mass, but great difficulties have been encountered in arriving at a general method, perhaps chiefly because it has not been possible satisfactorily to define what is meant by workability. The workability of the concrete mass would appear to be made up of two almost conflicting properties, viz., good mobility and good cohesion. At the works carried out by the Board of Waterfalls vibration tables are employed for determining consistency, and the workability—or, rather, the plasticity—is judged from the appearance of the mass on the vibrator table before and after shaking. The photographs shown in Fig. 13 are used as a guide for the classification of the concrete, both in the laboratory and in the field. It is, of course, obvious that such an estimate will be very approximate and even subjective, but in spite of that it has constituted a good check on the workability.

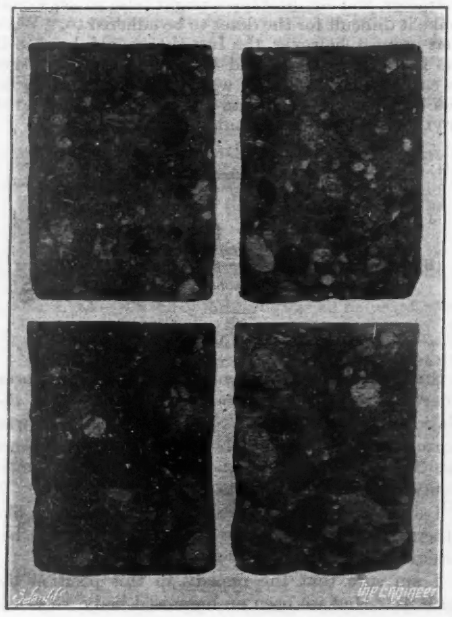


FIG. 12—CONCRETE CONTAINING 325Kg (above) AND 175Kg (below) LOW HEAT CEMENT PER M3

In considering the impermeability of a concrete structure the formation of cracks, the separation of concrete beneath the reinforcement bars, &c., are of importance. The cracks with which we are concerned in this connection are those arising on account of shrinkage owing to the dissipation of the heat of hydration or to drying out, and those due to fall in the air temperature.

The variation of the temperature in a concrete wall 60 cm. thick is shown in Fig. 14. After two days the temperature has attained its maximum and then begins to fall, so that after a week the structure has practically returned to the initial temperature of the concrete mass. The curves apply to concrete with 350 kilos. low-heat cement, but the process is approximately the same for all sorts of Portland cement, though naturally with the temperature rise in proportion to the heat generated. At a great rise in temperature of a concrete, which may have hardened and therefore become brittle before the heat of hydration has dissipated, it is naturally more liable to formation of cracks than a tougher concrete with relatively low temperature rise. It should therefore be an advantage if the fall in temperature takes place early, *i.e.*, while the concrete allows of great plastic deformation. Comprehensive research into plastic deformation in concrete is at present being carried out at a number of large laboratories, such as Building Research Station in England, and American Portland Cement Association in U.S.A. Up to now it has been found that slow hardening of the cement, low content of trisilicate, and coarse grinding promote plastic deformation to a high degree. And this applies not only to the first month of hardening, but also in certain degree to the following months. To lessen crack formation in concrete a special cement for hydraulic structures should have low heat generation and contribute to plastic deformation in the concrete.

In this connection it may be well to make a comparison between the Swedish low-heat cement and other kinds of Portland cement. The cement most nearly approaching the Swedish low-heat cement is the American low-heat cement which was used for the Boulder dam. The proportions of the ingredients of the two cements are practically the same, and the difference lies almost entirely in the fineness of the grinding. With the object of achieving a better workability in the concrete mass and better strength in the concrete after a comparatively short period the employment of fine grinding is carried very far in America. In Sweden we have required a longer setting time to allow a slow pouring and long time for working the concrete mass. Workability can easily be regulated by means of admixtures and the slower growth of strength is as a rule no drawback, provided the final strength is good. Further, since the research of recent years has shown that plastic deformation is greater with coarsely ground cement than with finely ground, coarser grinding in low-heat cement may be preferable.

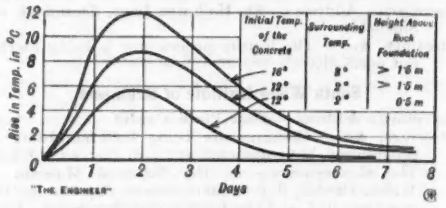



FIG. 14—TEMPERATURE RISE IN 60 CM CONCRETE WALL

Compared with Portland cement, Swedish low-heat cement is not only more coarsely ground, but has also other proportions of certain compounds, viz., the

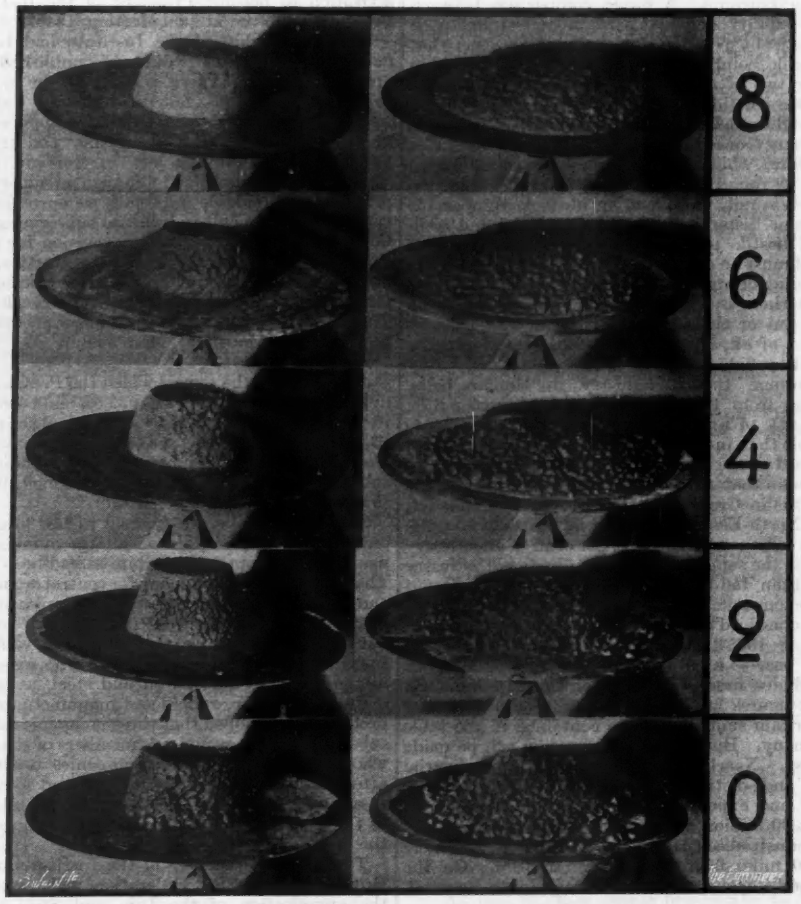



FIG. 13—"WORKABILITY" CLASSIFICATION

trisilicate content is lower and the disilicate content higher than in ordinary cement. The result of this is very slow increase in strength, as is apparent from Figs. 15, 16, and 17.

Fig. 15 shows the increase in strength in cement mortar cubes with low-heat cement, partly with normal sand and made in a hammer apparatus, partly with concrete sand and plastic mortar. As

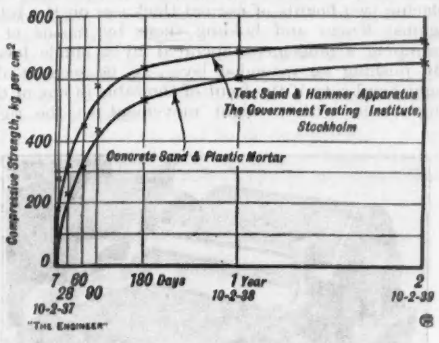



FIG. 15—CURING CURVES

may be seen, the growth of strength is still proceeding after two years' curing.

Fig. 16 shows the relation between water-cement ratio and compressive strength in concrete cylinders with low-heat cement after water curing for twenty-one and thirty-five days.

Fig. 17 shows the growth of strength in concrete with low-heat cement from Suorva. The sand and

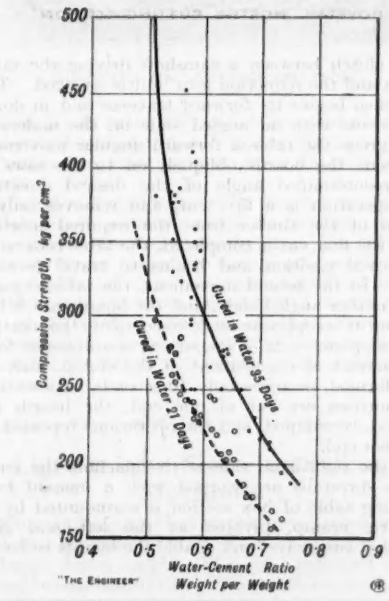



FIG. 16—EFFECT OF WATER-CEMENT RATIO ON STRENGTH

stone in this concrete is mainly crushed material. Also in this case the growth in strength is considerable after a long time of water curing.

Long binding time and slow hardening, however, involve the drawback that the tendency to the occurrence of "drying cracks" in horizontal upper faces is increased. Extensive tests in the field show that these cracks are due to contraction of the upper face, owing to cooling and evaporation of water, together with the expansion of the lower parts on account of the heat generated. Tests have shown that pouring up to 5 cm. above the final surface level constitutes sufficient insulation to avoid cracks. The surplus is scraped off six to eight hours after the working of the concrete is finished. Cracks could, of course, also be avoided by protecting the upper face in some other manner against cooling and evaporation. Trials have shown, for instance, that enclosing the concrete in a heat chamber, as is usual practice in cold climates, and raising the temperature by steam admitted, is a very effective protection against the occurrence of such cracks.

An attempt to equalise the temperature difference in the concrete by a large amount of displacers did not, on the other hand, prove entirely successful; nor did the embedding of a reinforcement net in the upper face have the intended result.

In conjunction with the question of the fine grinding of cement, the result is given in Fig. 18 of a German investigation of the effect of grinding on shrinkage. The investigation was described in the journal *Zement*, 1938, page 658. In the diagrams the grinding is expressed as the residue on screen with 4900 openings per square centimetre, and if the screen residue may be taken as expressing the grade of grinding, it is apparent that the coarser the cement is the less is the shrinkage. Coarse grinding would thus appear to give not only increased plastic deformation, but also lessened shrinkage. Reduced shrinkage

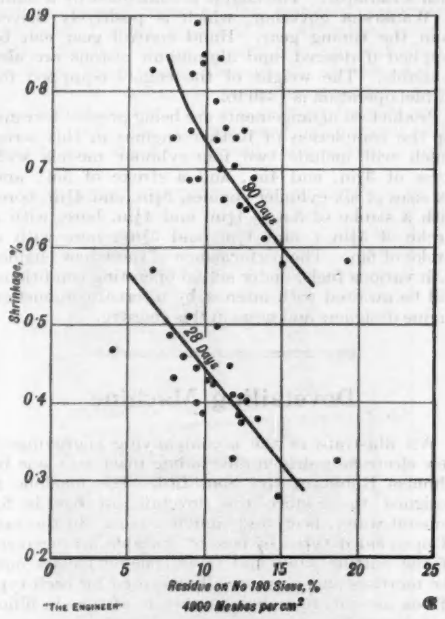



FIG. 18—EFFECT OF GRINDING ON SHRINKAGE

should always be an advantage; on the other hand, there may naturally be cases where plastic deformation may not be desirable, and it is obvious that for each individual case it is necessary to consider what kind of cement is the most suitable.

In respect of prolonged setting time, it has been found that an extended time of working the concrete mass contributes to better uniformity, and consequently also to water-tightness in floated concrete. As previously stated, it has also been proved that the formation of voids beneath reinforcement bars has been lessened and adhesion improved by slow rising of the mass in the form. But the cement should then be of such a nature that the concrete strength is not impaired by the prolonged working.

Fig. 19 shows the growth in strength in concrete of low-heat cement for different periods of punning. The curves are grouped on either side of the curve corresponding to normal working, without any tendency to weakening being observable, even after punning has extended over ten hours.

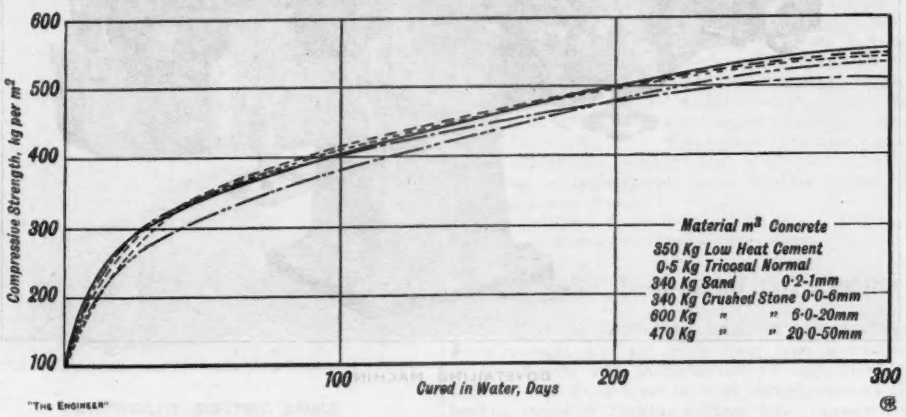



FIG. 17—COMPRESSIVE STRENGTH OF CONCRETE FROM SUORVA

### SUMMARY

Concrete for hydraulic structures should have a fairly high cement content; preferably at least 300 kilos. per cubic metre of finished concrete for a maximum size of stone of 100 mm. and at least 325 kilos. per cubic metre when smaller stones are used.

The cement should give the least possible shrinkage but relatively great plastic deformation to the concrete.

The concrete mass should be mobile, but at the same time so plastic that no risk of separation arises during the conveyance to the forms.

Large stones should be employed in order to obtain the greatest possible strength, while maintaining impermeability and workability.

The water curing should be ample and be continued for a considerable time, preferably until the structure is set under water.

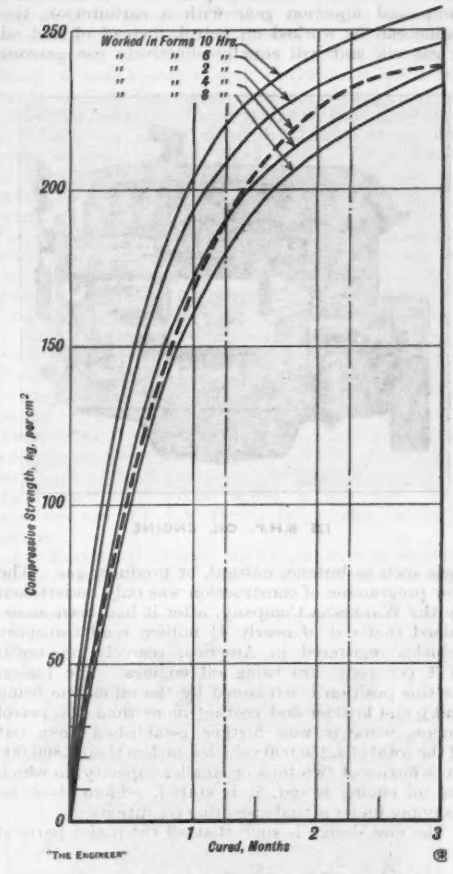



FIG. 19—INFLUENCE OF TIME OF WORKING

## BRITISH STANDARDS INSTITUTION

*All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 2d. post free, unless otherwise stated.*

### ABRASIVE PAPERS AND CLOTHS

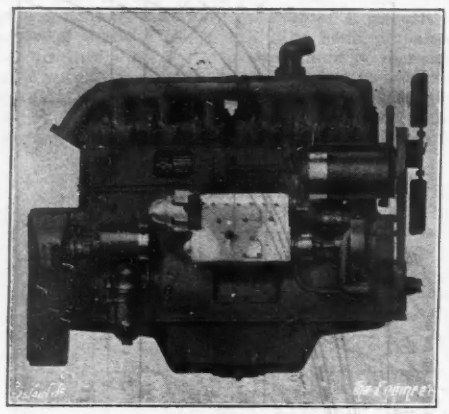
(B.S. Nos. 871 and 872).—One of these new specifications deals with what are known in the trade as "Technical Products," and the other with papers and cloths for general purposes. The specification for Technical Products covers abrasive papers and cloths for engineers, wood working, rubbing down filler, paint, and lacquer surfaces, and general utility work. This specification covers flint papers, silicon carbide papers, garnet papers, and aluminium oxide metalworking cloth. The specification for general purposes includes emery cloth, glass paper, glass cloth, flint paper, and flint cloth. It has not been found possible at this stage to include a comprehensive test for the quality of the finished product as there is insufficient data available to form the basis of test requirements. Experiments are being made and the subject will be given further consideration when, in due course, the specifications come up for revision. In view of the fact that it is not possible to specify grading requirements for the abrasive and since it was felt that no special advantage would be gained by the provision of cards to illustrate the grading on each specification, it has been decided, for reference purposes, that coated samples and samples of standard sands shall be deposited at the offices of the Institution.

### CALORIFIERS

(B.S. No. 853).—This specification deals with riveted and welded steel, cast iron and copper calorifiers for central heating and hot water supply. It is one of a series of specifications for land boilers issued by the Institution, and covers steam heated calorifiers of any capacity and water-to-water calorifiers of over 50 gallons holding capacity. Requirements are included governing the quality of material, the construction and workmanship, scantlings, and the inspection and testing of the calorifiers, the heating element being dealt with separately. Additional provisions are also included with regard to the various types of mountings and appliances fitted to calorifiers, an important feature being a graded series of standard sizes of relief valves according to the size of the calorifier. Price 3s. 8d., post free.

## A Multi-Fuel Engine for Road Transport

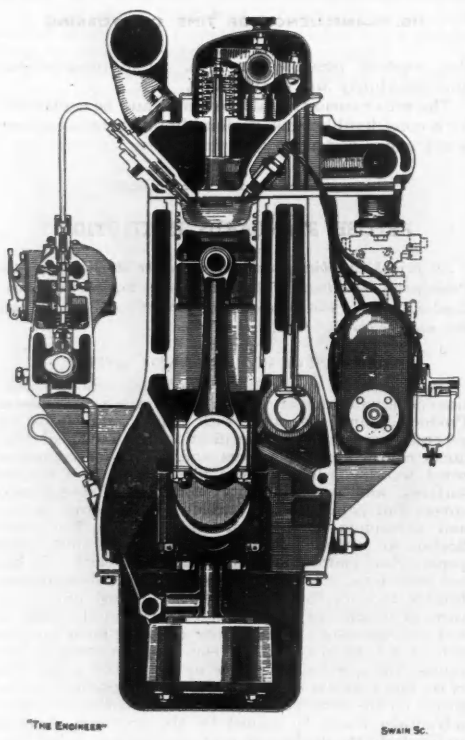
WE illustrate in the accompanying engravings a new type of engine which has recently been placed on the market by the Waukesha Motor Company of Waukesha, Winconsin, U.S.A. It has been designed to supersede the existing pattern of Waukesha side-valve Hesselman oil engines with spark ignition, and is so constructed that, by interchanging the fuel pump and injection gear with a carburettor, the engine can be worked on petrol, instead of fuel oil or gas oil, and will equally effectively use gaseous



125 B.H.P. OIL ENGINE

fuels such as butane, natural, or producer gas. The new programme of construction was only undertaken by the Waukesha Company, after it had been ascertained that out of nearly 4½ million road transport vehicles registered in America, scarcely one-tenth of 1 per cent. are using oil engines. The reason for this position is explained by the oil engine being bulky and heavier and costing more than the petrol engine, while it was further established that out of the total of 4,250,000 vehicles, no less than 3,800,000 were lorries of two tons or smaller capacity, in which the oil engine would, it is stated, seldom show an economy under actual operating conditions.

The new design is such that all the major parts of




SECTION THROUGH ENGINE

the engine are the same, whether it is to be run as an oil engine or a petrol engine or to utilise gaseous fuel. The engine we illustrate is the first of a series of six-cylinder engines, having a designed output of 125 B.H.P. at 2100 r.p.m. The cylinders have a bore of 4¼in. and a stroke of 5½in. In order to convert the engine from an oil engine to a petrol engine, it is only necessary to remove the elbow on the air intake on the right-hand side of the engine and fit a carburettor. The injection equipment on the left-hand side of the engine is omitted, and in place of the fuel injection nozzles, screwed plugs of equivalent volume are fitted, so that the compression ratio of about 5·8 to 1 is maintained. The fuel consumption of the engine on fuel oil is below 0.5 lb. per B.H.P. hr., and even lower fuel consumptions have been obtained when using petrol as a fuel. The general construction of the engine is shown in the accompanying section. The bedplate and cylinder casing are cast in one piece, and the oil sump is bolted on to the underside of the bedplate. The crankshaft, which has seven 3in. diameter bearings, is carried within the casing, which has main bearings well supported by ribs. The bearings have steel shells lined with white metal. The connecting rods are of heat-treated steel, with a steel white-metalled bottom end and a bronze bearing for the gudgeon pin, which is of the full floating type. The liners are made of special Waukesha moly-chrome iron, and are removable. The pistons are of cast iron and carry three $\frac{3}{16}$in. pressure rings and one ¼in. oil control ring, all of which are above the gudgeon pin. The cylinder heads are made in two castings, each carrying three cylinders, with the necessary provision for the water-cooled exhaust ports and the injection nozzles and sparking plugs. Overhead valves of special alloy steel, operated by push rods from the camshaft, are employed, and the valve gear is enclosed by a casing.

Our illustration clearly shows the arrangement of the fuel pump, circulating water and oil pumps, and oil filter, also the belt-driven cooling fan for use with a radiator. The engine is controlled by a built-in Waukesha governor, which is positively driven from the timing gear. Hand control gear can be supplied if desired, and aluminium pistons are also available. The weight of the engine equipped for oil fuel operation is 1340 lb.

Production arrangements are being pressed forward for the completion of further engines in this series which will include two four-cylinder models with bores of 3¾in. and 4in., and a stroke of 5in., and six sizes of six-cylinder engines, 3¾in. and 4⅛in. bore, with a stroke of 5in.; 4¼in. and 4½in. bore, with a stroke of 5½in.; and 4¾in. and 5½in., bore with a stroke of 6in. The performance of these new engines with various fuels, under actual operating conditions, will be awaited with interest by internal combustion engine designers and users in this country.

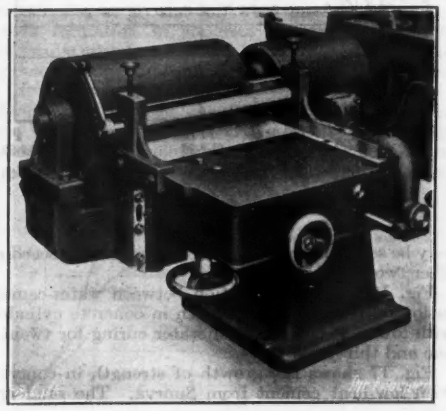
## Dovetailing Machine

WE illustrate in the accompanying engravings a new electrically-driven dovetailing machine made by Thomas Robinson and Son, Ltd. The machine is designed to produce the dovetails in boards for mineral water, beer, and similar boxes. In the case of open-sided types of box by suitable arrangement of the cutting saws and their spacing collars only the mortises and pins actually required for each type of box are cut, there being no waste of time in filling up unwanted mortise gaps.

The machine comprises two sections, the left-hand side for cutting the mortise dovetails, and the right-hand side for cutting the tenon or pin dovetails. Boards can be machined in pairs, and since two operators can work together, the sides and ends of a complete box can be worked "in step." The output from the machine is chiefly governed by the deftness of the operators in handling the boards; it is claimed, however, that even with second-class labour a production of up to 250 boxes per hour can be maintained, since the machine is quite simple to operate.

Dovetailing is carried out by means of stout-gauge circular saws, of uniform diameter and given a special set on the teeth. Any number up to 36 saws can be used in combination, but not more than 18 on each side of the machine, the number used depending on the type and size of box required. The saws are mounted on a heavy spindle which forms the rotor shaft of a 12½ H.P. A.C. squirrel-cage driving motor built into the head of the machine pillar. Should the use of this standard arrangement be impracticable, either by reason of the type of current available or special electrical regulations, the machine can be driven by multiple vee-belts.

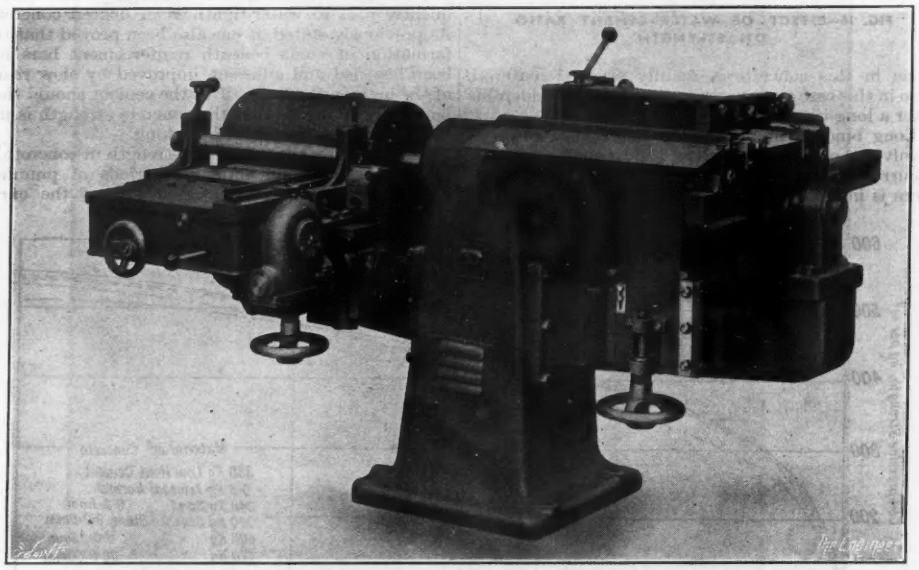
On the left-hand, or mortising side of the machine, there is a sliding table, operated by a ½ H.P. motor and combined reduction gear unit. The operation of cutting the mortise dovetails is performed by placing two boards of normal thickness on the table against fences and holding them by means of a cramping arrangement operated by a single lever. By pushing an extended lever, to be seen at the right-hand side of the front of the table in one of the engravings, with a slight movement to the right



DOVETAIL MORTISE CUTTING SECTION

a dog clutch between a camshaft driving the table motion and the reduction gear unit is engaged. The table then begins its forward traverse and in doing so connects with an angled slide on the underside which gives the table a forward angular movement and feeds the boards obliquely on to the saws at the predetermined angle of the desired dovetail. This operation is a first cut, and removes only a portion of the timber from the required mortise. When the first cut is completed, the table returns to its normal position and begins to travel forward again. In the second movement, the table engages with another angled slide, and the boards are fed to the saws at an opposite angle to complete the mortise. This complete cycle of operations is automatic from the moment of engagement of the clutch, and, we are informed, occupies only 10 seconds. As soon as the mortises are cut at one end, the boards are reversed, recramped, and the operations repeated on the other end.

On the right-hand side of the machine the tenon or pin dovetails are worked with a manual feed. A rolling table of box section is surmounted by an eccentric cramp, pivoted at the left-hand side, so that it can swivel and enable the boards to be fed



DOVETAILING MACHINE

to the saws at the required angle. Its operation is shown clearly in an accompanying engraving. The rolling table is firstly drawn back to its normal position towards the front of the machine, and the eccentric cramp is pulled forward against a front stop. Two boards are then inserted, located against a platen and fence, and cramped. Whilst holding the cramp back against the stop, the whole unit is pushed forward over the saws to make the first cut. When the boards have cleared the saws, the cramp is pushed back until it comes into contact with a stop at the

rear of the table, and is held in this position, while the table unit is pulled back over the saws to make the second cut and complete the operations. The boards are then taken out, turned over, recramped and the operations repeated for the other ends.

Adjustments on the machine are claimed to be simple, and we are informed that tight or slack dovetails can be made at will. Furthermore, mortises and pins can be adjusted by means of gauges to match, thus minimising subsequent cleaning up operations. As already mentioned, the machine can be adjusted to give special dovetails on boxes on which drain openings are required, or in cases where each side of the box consists of two rails with a gap between them.

The machine is claimed to be exceptionally clean in operation, since all cutting waste is in the form of sawdust and consequently easy to exhaust. The

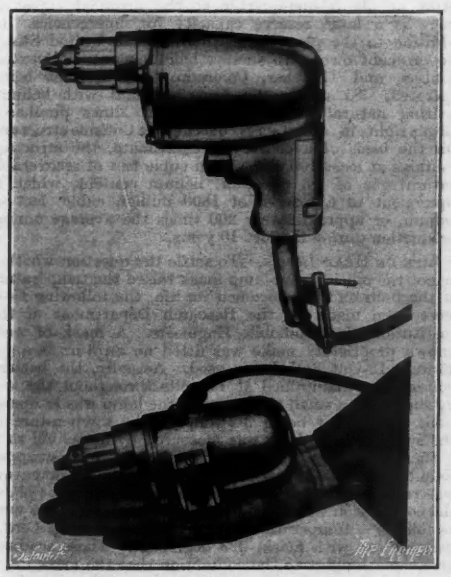
DOVETAIL PIN CUTTING SECTION

exhaust hoods fitted give safety protection and are constructed so that they can be easily connected to a central suction plant, or to bags for the collection of waste.

When it is desired to keep the machine in constant production, it is recommended to have two sets of saws, so that one set can be kept sharpened in readiness for an immediate change-over when necessary. To change over a full complement of saws is stated to take but a few minutes, and is only necessary at infrequent intervals. In fact, the manufacturers of the machine state that one machine has dovetailed 25,000 boxes before re-sharpening was necessary.

## Lightweight Electric Drilling Machines

Two new designs of lightweight production drilling machines, manufactured by S. Wolf and Co., Ltd., of Hanger Lane, London, W.5, are illustrated in the accompanying engraving. The machines each have



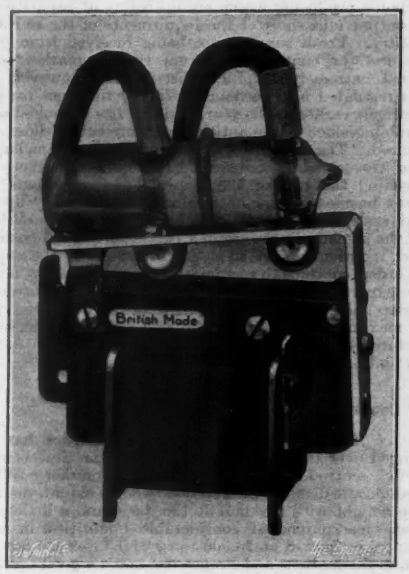
LIGHTWEIGHT ELECTRIC DRILLS

a maximum capacity of ¼in. and are made in two patterns, differing only in the arrangement of the body. Known as "Torky" drills, the type TH.2 has a pistol grip and is furnished with a trigger switch, whilst the T.P.2 type is a hand model with a thumb-operated slider switch. The machines are very compact and light, the overall length in each case being but 6½in. For the TH.2 model the weight is stated to be 2 lb. 6 oz., and in the case of the T.P.2 to be 2 lb. 4 oz. Designed primarily for light production work, their lightweight and general handiness makes them very suitable for drilling duralumin and other metals commonly used in the aircraft and other light industries.

The armature and drilling spindle are mounted on ball bearings, and spiral reduction gearing, made of heat-treated nickel chrome steel, is used. Running light, the drill spindle speed is stated to be 2500 r.p.m. and the makers give, as the result of tests, a speed of 1657 r.p.m. on full load and a consumption of approximately 166 watts. The tests carried out have included a full load test for 1000 hours, which, we are informed, was completed with satisfactory results. Each pattern of drill is supplied with 15ft. of three-core C.T.S. cable, a ¼in. three-jaw keyed chuck, and a spare pair of carbon brushes.

## Improved Relays

IMPROVEMENTS in mercury switch relays are announced by Londex, Ltd., of Anerley Works, 207, Anerley Road, S.E.20, which is now supplying triple pole relays up to 50 amperes. The illustration gives a general view of the standard apparatus designated Londex type L.Q.A. All relays have a highly efficient magnet circuit, the core and tilting armature being made throughout of laminations composed of high-grade magnetic material. Continuously rated the coils are suitable for 600 volts A.C. or D.C., or, in the case of current coils 50 amperes. On A.C. the coil consumption is only




MERCURY SWITCH RELAY

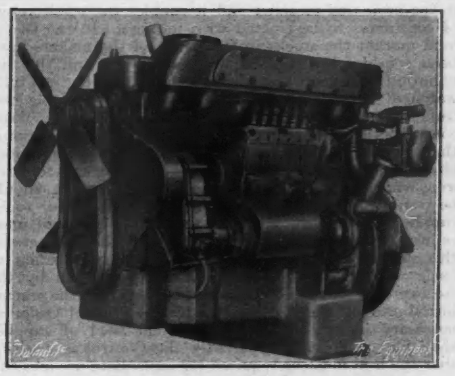
2 VA and on D.C.1 watt. In the case of A.C. excitation the relays are fitted with shaded poles with a highly polished surface to secure silent working. Ample power is available to operate the several heavy-duty mercury switches and the simple tilting principle enables the "on" and "off" positions to be clearly seen. Mercury switches can be fitted to "make" and "break" or to change over as required.

The relays have many applications as, for example, the remote control of street lighting, for use with lifts, motor control, and for the automatic change-over to a stand-by supply in hospitals, etc. Special forms of the relays are available for push-button control and delayed operation. For currents above 6 amperes, switching capacity, mercury switches are used with a strong porcelain liner fused into the glass tube between the electrodes. This construction gives good mechanical strength and provides arc protection, making the switch suitable for high voltage and D.C. circuits. The relays are said to have proved to be thoroughly reliable and a number of other electrical manufacturers have adopted them for various classes of work.

## 6-Cylinder Industrial Oil Engine

THE firm of F. Perkins, Ltd., of Queen Street, Peterborough, has for some time past specialised in the design and manufacture of high-speed oil engines, and from time to time descriptions of the leading types of Perkins engines have appeared in these pages. The engine we show in the accompanying engraving, is of particular interest, as it marks an important addition to the range of engines manufactured by the firm, and is of higher output than the industrial engines which have up to the present been marketed by the firm. The marine version of this engine has already been described in our pages. The new engine is known as the "S61" model, and it has six cylinders with a bore and stroke of 4¾in. and 5in., a capacity of 7·3 litres, and a designed output of 50 B.H.P. at 1000 r.p.m., and 110 B.H.P. at 2000 r.p.m. As will be gathered from our engraving, the engine embodies in its construction many features of standard Perkins practice, which have been associated with the firm's "P6" and "P4" industrial engines. Like these models the engine has a cylinder block and crankcase which is a single casting of chromium high-duty cast iron, to which are attached the aluminium alloy sump, the valve covers, and the covers for the timing gear. The design of the engine body is such that it can easily be mounted on a fabricated base-plate for generator driving, or can be built into the chassis of a railcar or an excavator. The bearings are seven in number, and have steel shells with a lining of lead bronze alloy. Provision is made for water cooling the main bearing seatings, which materially assists in the removal of heat generated at the bearings, and is, the maker's claim, an unusual refinement in an engine of this capacity. The cylinder head casting is also of chrome iron and is made in two units, each a one-piece casting carrying the tappets and rocker gear with two overhead valves. The cylinder heads can be removed for examination without disturbing the valve timing. Turning to the running parts, the crankshaft is made from special alloy steel, which is heat-treated and hardened. Integral balance weights are provided, and the shaft is fully balanced. The connecting rods are alloy steel stampings of "H" section, and the pistons are of aluminium alloy, and carry three pressure rings and two scraper rings one above and the other below the floating gudgeon pin. The fuel pump is of C.A.V. Bosch pattern, with a governor designed to control the speed of the engine within 4 per cent. permanent variation, and 10 per cent. momentary variation. Hand control of engine speed is provided. The atomisers are of C.A.V. Bosch design with two-hole nozzles.

For starting, the engine is arranged with an electric starter, comprising a 24-volt electric motor, a starting



110 B.H.P. INDUSTRIAL OIL ENGINE

battery, and a 12-volt belt-driven dynamo. A trickle charger can also be supplied instead of the dynamo. Should air starting be preferred, an air-starting motor can be fitted, instead of the dynamo and motor, and the air supplied by a small petrol engine driven air compressor, with the necessary distribution block and starting valve. To assist starting, the engine has a hand-operated decompressor gear. For cooling there is a belt-driven fan and water-circulating pump, and a self-contained radiator or a small cooling tank can be supplied. The cooling of the engine cylinders, has received particular attention and water is pumped under pressure into the cylinder head at six points, an arrangement which ensures a continuous flow of water being maintained around the atomisers. With this special cooling, it has been shown that there is practically no choking or carbonisation of the holes in the atominiser nozzles, and the atomisers require no attention. The cooling of the cylinder block has been carefully studied, and the cylinder jackets are carried down the entire length of the cylinder block, so that they form a cooling jacket for the seatings of the main bearings to which we have previously referred. Should they be required, a water-cooled exhaust manifold, complete with thermometers, can be provided. The lubrication of the engine is effected by pressure, and the lubricating oil is cooled by means of an oil cooler in circuit with the cooling water system. Other fittings include an air cleaner of the oil-bath pattern, and a Burgess silencer with appropriate exhaust piping connections. On the fuel and the lubricating oil circuits two independent filters are provided for each circuit.

In conclusion it may be stated that the continuous 12-hour rating of the new model at a speed of 1800 r.p.m., represents only 77 per cent. of the maximum rating of the engine, and therefore allows a good overload capacity. The governed speed of 1800 r.p.m. on the 12-hour rating only, represents 60 per cent. of the designed maximum speed of the engine, and for intermittent services such as railcars, locomotives, etc., a governed speed of 2000 r.p.m. is only 67 per cent. of the designed maximum speed. The favourable power-weight ratio achieved with the "P4" and "P6" models has been maintained with the new industrial engine described.

# Markets, Notes and News

**The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quotations are f.o.b. steamer.**

### Our Imports and Exports

The Board of Trade Returns for October have again made their appearance in their condensed form and presumably will do so for the duration of the war. Very few particulars are given, but the value of imports of iron ore and scrap in October amounted to £822,480, an increase of £40,228 compared with the figure for October, 1938. Imports of iron and steel and manufactures thereof rose to £1,081,717 compared with £319,635 in October last year. There was, however, a decrease in the imports of non-ferrous metal and manufactures thereof which, valued at £2,637,317, show a decline in value compared with October, 1938, of £1,109,735. Machinery was imported in October to the value of £2,120,760, a rise of £342,765 over the figure for the corresponding month of last year. The exports of iron ore and scrap were insignificant and amounted to only £1090, a decrease on the figure for October, 1938, of £60,797. The value of iron and steel and manufactures thereof exported in October reached £1,901,799, a decrease compared with October, 1938, of £1,534,343. Machinery was exported in October to the value of £2,057,805, a drop of £2,781,173 compared with the corresponding month of 1938.

### The Pig Iron Market

The present method of distributing pig iron amounts virtually to a rigorous system of rationing. All consumers have to obtain licences to buy pig iron and it is understood that the Control when issuing these takes into account the stocks held by the applicant. It is intended apparently to discourage the usual method of holding reserves against a rainy day, and those with material in hand are kept waiting whilst others have no difficulty in obtaining their requirements. Naturally there is some grousing at this system, but on the whole it has been well received and it enables the whole range of consumers to be treated with fairness. In the Cleveland market the stocks in the hands of the makers have been considerably depleted by recent calls and the distribution of the existing accumulations is being carefully watched. This has resulted in the larger use of pig iron from the Midlands, although most north-east coast consumers have been following the practice of obtaining their iron from this source for a long time. Suggestions have been made lately that the make of Cleveland foundry iron, which has been in abeyance for some months, should be resumed as this would enable local customers to be supplied and relieve a certain amount of pressure upon railway transport. On the other hand the furnaces in this district are concentrating upon the production of basic which is being used in large quantitites by the steelworks. The Midland market has accepted the scheme introduced by the last Iron and Steel Control Order as necessary in order that firms in real need of supplies shall not go short. Apparently the Control is insisting that the iron must be required for immediate use and this prevents consumers building up stocks whilst others are starved. There is a strong demand for pig iron of all descriptions in Scotland and the activity which now rules at most of the light castings foundries has provided an outlet for heavy quantities of pig iron. The Scottish blast furnaces would appear to be well supplied with ore and fuel and their production is at a high rate. Some complaint is heard of the difficulty of obtaining full supplies of scrap, but it is assumed that this will shortly be overcome by increased imports. An insistent demand rules in the hematite iron market and the stocks which were weighing upon the makers' hands a few months ago have been largely liquidated and the producers are now disinclined to accept contracts for delivery over long periods.

### Scotland and the North

In spite of the huge production of the Scottish steelworks orders continue to accumulate and there is a gradual extension of the periods required for delivery. With all the Clyde yards busily employed a large tonnage of shipbuilding material is passing into consumption. The demand for structural material is expanding rather than the reverse and the pressure upon the steelworks is correspondingly increasing. The constructional engineers in Scotland are also fully engaged, almost entirely upon Government work and this industry also is providing an outlet for large tonnages of joists, sections and other structural steel. A good proportion of the output of the steelworks comes within the priority categories and as a consequence there is little chance of steel for commercial purposes being supplied for a long time to come. Some export business in this class of material has been accepted lately, and it is evident that the trade with the approval of the authorities will endeavour to resume export business upon as large a scale as is consistent with home requirements. The overseas demand, however, is irregular, and whilst some markets are anxious to buy, other countries show a disposition to hold aloof. The Scottish re-rollers are producing at a high rate of capacity. The major proportion of the output is in the form of structural steel of the smaller sizes which are being used in large quantities. The sheet works are maintaining a good output and some of them are now willing to entertain export inquiries. The home demand, however, is still sufficiently insistent to restrict the quantities available for overseas trade. The wrought iron works are busier than they have been for years and are securing a considerable amount of business from engineers, railways, wagon builders and the shipyards. There is a large production of iron bars and sections and in this department also delivery dates tend to lengthen. The difficulty of obtaining steel is also diverting a considerable tonnage of business to this industry. In the Lancashire market the consuming trades without exception are busy and the tank, boiler and locomotive builders are all taking up large tonnages of plates. The pressure to obtain alloys and special steels shows no signs of diminishing and a heavy business is passing in bright steel bars. The demand for blooms and billets is on a heavy scale and forging qualities are in strong request.

### The Midlands and South Wales

Consumers continue to search the market for supplies of steel and under this unrelieved pressure there is a tendency for producers to fall into arrears with deliveries. The Control, however, is carefully watching the position and is making great efforts to ensure an equitable distribution of material. Care is being exercised in issuing licences to ascertain that the applicant does not possess stocks, in order that the available quantities may be distributed to those firms urgently requiring material. The bulk of the demand is, of course, for structural steel. The constructional engineers and the shipyards take up by far the largest tonnages produced, and since contracts are being continually given out there is little chance of the position in this department becoming easier. One of the features of the midland trade is the sustained demand for colliery steel. The scarcity of supplies for this purpose has increased the demand for steel and large tonnages of rails, roofing bars, and arches are passing into consumption. The re-rolling works are busy, but their operations are adversely affected by the stringency in the supply of billets and sheet bars. The demand for billets is particularly heavy, although the home producing works are operating at capacity and the output falls short of the requirments of the re-rolling industry. Fresh supplies are being received from overseas and the contributions from Empire markets have proved extremely helpful. Distribution, however, has been regulated in accordance with the tonnages used by consumers earlier in the year, and this has provoked some grumbling since the quantities were far below those now required. The sheet mills are still in full operation, largely upon Government contracts. They are, however, approaching the end of the heavy A.R.P. demands and export business is now entertained although only upon a small scale. In South Wales the steelworks are all busy and the tinplate works are in a particularly good position. Their requirements of steel are in excess of the supply and orders continue to accumulate upon the makers' books. The export demand is steady and overseas customers appear quite willing to pay high prices compared with the maximum fixed by the Control for the home trade. Quotations in this market are 21s. f.o.t., and for export 32s. f.o.b., 20 by 14 basis.

### Copper and Tin

The situation in the copper market has not changed over the week and interest for the time being is chiefly centred upon the American market. Whilst the domestic demand has receded to some extent, neutrals have bought with freedom at 13c. f.a.s. and a little over. Russia has purchased considerable quantities, in some quarters estimated at 20,000 tons, whilst Sweden has also been in the market, and France has taken a good tonnage. Some difficulties, however, have been experienced in obtaining shipping to carry the metal to Europe, owing to the cash and carry terms of the American Neutrality Act. There is a suspicion that attempts have been made to secure copper for Germany, but whilst there may be a small leakage very little is going through to that country. For one thing Germany's behaviour to some of the neutral nations has aroused hostility, and for another, it is practically impossible for Germany to pay cash, and few nations are satisfied with her suggested barter arrangements. There is plenty of copper available in Great Britain, and the possibility of a stringency is not envisaged by the trade. In fact, it is suggested as probable that the consumption of copper by the belligerent countries will be much less than in the last war, and that as Great Britain and France have obviously prepared on the basis of the 1914–1918 requirements there may be a surplus in the future. The danger which the London market fears is that as a result of the closing down of the Metal Exchange by the Ministry of Supply the supremacy of this country in the non-ferrous metal trade will be lost. . . . There is a good demand for tin in this country, but the market in London is still restricted to 25 tons daily. The position, however, should grow easier as considerable tonnages of ores are arriving here and the action of the International Tin Committee in increasing the export quotas should result in a more comfortable situation developing over the next month or two. In the United States the demand appears to have expanded somewhat of late, and prices are still about £30 to £40 over the British official quotation of £230. It is reported that one of the big American refining companies proposes to commence smelting tin ores. During the last war an attempt was made to establish a tin-refining industry in the United States, but when the war was over the project was abandoned. The present intention apparently is to refine Bolivian ores in the United States and this might divert some of the supplies which would normally come to this country.

### Lead and Spelter

The lead-consuming industries are working at high pressure and are receiving full supplies. The Control, however, is endeavouring to ensure that new purchases shall not be used for the building up of stocks. Consumers who urgently need the metal, however, find their wants dealt with quickly, and in this respect the Control is working much more smoothly. The only complaint is by firms employed on work which is not of national importance. These consumers naturally have to wait until the requirements of those engaged upon Government and similar contracts are satisfied. Consumers also are largely obtaining their metal through normal channels, that is, as a rule, through merchants. In this they are meeting the wish expressed early in the war by the Control, but so far no agreement has been reached with the Ministry of Supply by which the merchants can obtain any remuneration for their work. There may be some stringency in the prompt position, but it is understood that production is increasing and any tendency in this direction should be overcome. In the United States the market has become quiet although the quotation is steady at 5.50c. New York. . . . Conditions in the spelter market are steady and generally speaking consumers appear to be satisfied with the conditions under which they work. Supplies are reaching them with regularity, and as most of the spelter-using industries are employed upon Government work and therefore come within the priority categories, little difficulty is found in obtaining the metal required. Strict control is maintained over the requirements of consumers and every effort is made to avoid some works accumulating stocks whilst others go short. The fact that no returns are available of shipments make it impossible to give any idea of arrivals in this country, but the general impression is that most of the metal coming to hand is of Canadian origin.

### Control of Aluminium

An important Order regarding the control of aluminium has been issued by the Ministry of Supply under which the Ministry becomes the sole seller of virgin aluminium. The Order is entitled the Control of Aluminium (No. 4) Order, 1939, under Regulations 55 and 98 of the Defence Regulations, 1939. This new Order came into force on November 24th, and revokes the Control of Aluminium (No. 3) Order, 1939. It repeats the main provisions of that instrument, which was that a licence is necessary for the purchase, sale or use of unwrought aluminium or aluminium alloys. As the Ministry of Supply is the sole seller no maximum price is necessary in the Order, but the Ministry has decided to sell aluminium in notch bar or ingot form until further notice at £110 per ton delivered into consumers' works with extras for other forms and purities. The maximum prices previously in force for aluminium alloys, virgin or secondary, and for scrap have been withdrawn, and no maximum prices are scheduled in the new Order. It is anticipated that they will find a reasonable level by reference to the new virgin ingot price. The price situation of these materials will, however, be closely watched over. Powers are taken to impose maximum prices at any time by Direction. All inquiries should be addressed to the Aluminium Control, Raven Hotel, Shrewsbury. Copies of the new Order may be purchased from H.M. Stationery Office, or through any bookseller.

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HELIUM.—According to the United States Secretary of the Interior the supply of gas available from the Government-owned helium plant near Amarillo, Texas, constitutes a practical world monopoly. The present plant equipment at Amarillo has a capacity of 24 million cubic feet of helium per year, and by installing another production unit in existing buildings the output could be raised to 36 million cubic feet per year. As the present military and commercial demands of approximately 6 million cubic feet per year are met by operating the plant at about one-quarter of the installed capacity, there is a large reserve capacity for emergencies. In addition to the plant near Amarillo, the United States Government owns two smaller helium plants at Dexter, Kansas, and Thatcher, Colorado, that are not being operated. To supply the Amarillo plant with helium-bearing natural gas, the Bureau of Mines purchased all gas rights in 50,000 acres covering the Cliffside structure. On the basis of a conservative estimate, the structure contains at least 100,000 million cubic feet of recoverable natural gas of 1·8 per cent. helium content, which is equivalent to a reserve of 1800 million cubic feet of helium, or approximately 200 times the average annual production during the last 10 years.

LIFE OF HEAD LAMPS.—To settle the question whether or not the official head-lamp mask raised the temperature of the bulb and so shortened its life, the following tests have been made by the Research Department of the Institution of Automobile Engineers. A mask of well-known proprietary make was fitted on an 8-in. lamp, a 36-watt 12-volt bulb being used. Actually, the battery voltage was maintained at 14 volts throughout the test by supplying a small charge while the lamp was in operation, the current being 3·2 amps. The temperature of the surface of the bulb was measured by attaching to it a thermocouple by means of a piece of wire wrapped round the bulb. It was found that a steady temperature was reached after about half an hour. In the first place, the comparison was made in still air, and the results were as follows: Temperature without mask, 205 deg. Cent.; temperature with mask, 223 deg. Cent. These readings give some support to the contention that the mask interferes with heat radiation, but it is not usual for the head lamp to be switched on with the vehicle at rest, so that a similar comparison was made with a head wind of 30 m.p.h. blowing on the lamp. Under these conditions the results were: Temperature without mask, 190 deg. Cent.; temperature with mask, 175 deg. Cent. These readings, therefore, show that under normal running conditions the temperature is lower with a mask, the reason obviously being that the mask constitutes a miniature radiator capable of dissipating heat in the presence of a wind. It should be noted that the effect of the 30 m.p.h. wind was to reduce the temperature of the plain head lamp by only 15 deg. Cent., whereas the reduction was 48 deg. Cent. with the mask, thereby emphasising the heat-dissipating properties of the mask.

# French Engineering Notes

*(From our own Correspondent in Paris)*

### War Time Labour Conditions

SIX weeks after the outbreak of war final touches were given to the plan for adjusting wages, working hours, and collective contracts to new conditions imposed by the national effort to bring production up to the limit of its capacity. There have been may decrees that constitute stages in the elaboration of this plan from the time when armament activity put a severe check on industry by absorbing skilled hands at higher wages and placing industrialists in a difficult situation by increasing costs when business could only be done by lowering them. While precedence is necessarily given to war requirements, the nation's ability to keep going depends upon production for an expanding home and foreign trade. There must be stability in wages and prices, a distribution of labour where it is most needed, and, in the circumstances, a control over men and employers to ensure that production is continued smoothly and without interruption. It was desirable to remove any unfairness or suspicion that workers in one class of production, such as armaments, were more favoured than others in engineering works engaged in maintaining the country's economic interests. Nor was it considered fair that men mobilised in works should be receiving good pay without contributing to the national fund for the relief of dependents on workers who had to leave their jobs to go to the front. A situation so complicated could only be dealt with by the State which, moreover, by reason of the mobilisation, controls the labour supply. There has never been a superfluity of skilled hands, and during the present intensive armament activity there is a dearth of them, so that the Minister of Labour has to distribute skilled men where their services are most useful. He is making up for the deficiency by organising centres for training specialised workers all over the country, and supplies of men are increased by a temporary demobilisation of the older army classes. Generally, there has been consultation with unions before framing decrees, and there does not appear to have been any disagreement in employing measures of a drastic character during the war. There is practically no limit to working hours when it is absolutely necessary to make the fullest use of the labour available, and for National Defence sixty hours a week are almost general, while in industry men work for as many hours as may be required for the execution of urgent contracts. The normal week is 45 hours, but inspectors from the Ministry of Labour may recommend an extension of hours when necessary. The principle of the forty hours' week, which still has a legal existence, though suspended by decrees, is observed when determining rates of pay for overtime. Such work is paid for at double the hourly wage for the first 40 hours, but 40 per cent. of the extra pay goes to the National Fund for the Relief of Soldiers' Dependents. It is, in fact, a contribution by employers, and workers of a mobiliseable age pay 15 per cent. of their wages to the fund. These conditions of hours and wages are confirmed by the last decree, which, furthermore, provides for a stabilisation of wages under conditions that prohibit employers from paying less than the minimum and more than the maximum scale. In the case of employers who are not engaged on work for National Defence, there is some latitude for a revision of collective contracts, but any changes must be approved by the Minister of Labour, who has the right to fix wages for categories of workers in any particular part of the country. So far as concerns work for National Defence wages are stabilised at those paid on the 1st of September, and the Minister alone determines any modification of the conditions of work and increases in wages. An important clause of the decree relates to the appointment of workers' delegates or shop stewards. Instead of being elected by the votes of workers their choice will be left to the respective unions. This precaution is intended to eliminate risk of a revival of Communist influence in workshops. The State has so far tightened its control of industry during the period of hostilities as to become absolute, and there is some apprehension as to whether this may not foreshadow some permanence of State control, but it is generally recognised that in present circumstances it could hardly have been avoided.

### Stratosphere Commercial Aircraft

A month after the event, under circumstances of strict secrecy, it was officially announced that, on the 13th of October, a stratosphere flight had been made from Paris to Rio-de-Janeiro with halts at Dakar and Natal, in Brazil. The appellation of stratosphere in this case implies an altitude of between 7500 m. and 9000 m. The machine used was the land-plane "Camille-Flammarion," weighing about 25 tons and belonging to Air France-Transatlantique, which was created by Air France and the Compagnie Générale Transatlantique mainly for air services across the North Atlantic. It was piloted by Codos and Guillaumet, accompanied by a wireless operator and a mechanic. Built in one of the national aircraft factories the machine bears indications of its being a Farman design. For a long while the Farman works, which are not nationalised, endeavoured to produce a type of commercial machine that would fly at very high speeds in a rarefied atmosphere that, to distinguish it from normal conditions, was called the stratosphere, but when the first machine was tested it came to grief and nothing more was heard of commercial flights at high altitudes until the laconic official announcement of the successful journey to South America. The South Atlantic was crossed from Dakar to Natal, in Brazil, in 12 hours at an average speed of 167 m.p.h., and the flight from Natal to Rio-de-Janeiro was accomplished in 10 hours. The idea of the so-called stratosphere flight for commercial services is to reach an altitude where atmospheric conditions are supposed to be constantly favourable, although there is still much to be learned about temperatures, humidity, and ice formation. A good deal of practical experience will have to be acquired, and complete security in passenger and navigation cabins ensured, before commercial air services can be undertaken in a rarefied atmosphere.

# British Patent Specifications

*When an invention is communicated from abroad the name and address of the communicator are printed in italics.*

*When an abridgment is not illustrated the Specification is without drawings.*

*Copies of Specifications may be obtained at the Patent Office Sales Branch, 25, Southampton Buildings, Chancery Lane, W.C.2 1s. each.*

*The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.*

## STEAM GENERATORS

513,196. October 14th, 1938.—IMPROVEMENTS IN WATER TUBE BOILERS, Hermannus van Tongeren, 34, Johannes Verhulstlaan, Heemstede, The Netherlands.

The object of this invention is to separate the flue coke in coal-fired water tube boilers from the hot gases before they pass through the bundles of steam generating water tubes. The flue coke is thus prevented from eroding the water tubes and from interfering with the heat transmission. The travelling grate of the boiler shown is indicated at A, the combustion chamber by B. The front and the side walls are lined with water tubes. Headers C supply water to and headers D discharge water and steam from the tubes. The rear wall of the combustion chamber is formed by a steep, forwardly sloping refractory baffle wall E resting on parallel water tubes. The tubes, which are supported by horizontal, water-cooled elements F, are provided with longitudinal fins so as to form a substantially impervious wall. Owing to the slope of its rear wall, the combustion chamber tapers upwardly. At its top, it communicates with a forwardly sloping flue G, of which the

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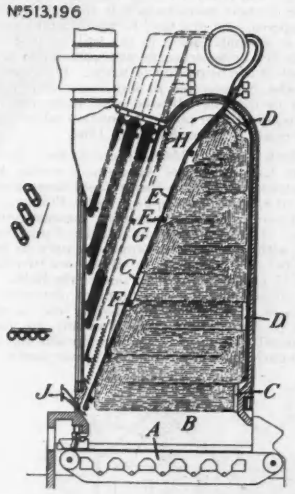


baffle E forms the front wall. The rear wall of the flue comprises a number of suitably spaced, transverse horizontal water tubes H arranged in parallel rows, and since the slope of the rear wall is steeper than that of the baffle wall, the flue tapers downwardly. The tubes H are connected to the circulating system. The lower end of the downwardly tapering flue opens vertically above the travelling grate and in the vicinity of compressed air nozzles J passed through the rear wall of the boiler. Owing to the upward taper of the combustion chamber, the hot gases will enter the flue at a high speed. These gases carry particles of coke and other solid matter, and if they pass through the flue, they will escape through the gaps and flow towards the chimney. The particles of coke, however, tend to follow the downward movement, owing to their inertia, so that they reach, together with a relatively small amount of gases, the lower end of the flue and fall on to the grate. If necessary, compressed secondary air jets are introduced through the nozzles to draw the solid particles from the flue and throw them onto the grate.—*October 5th*, 1939.

## INTERNAL COMBUSTION ENGINES

512,991. March 25th, 1938.—IMPROVEMENTS IN LUBRICATION SYSTEMS OF ENGINES, Benjamin Charles Carter, Royal Aircraft Establishment, South Farnborough, Hampshire.

This invention relates to lubricating systems for internal combustion engines of the dry sump type. It has for its object the provision of a system in which aeration and associated frothing of the oil is prevented while the oil level in the sump is kept sufficiently low to obviate oiling up of the engine. A

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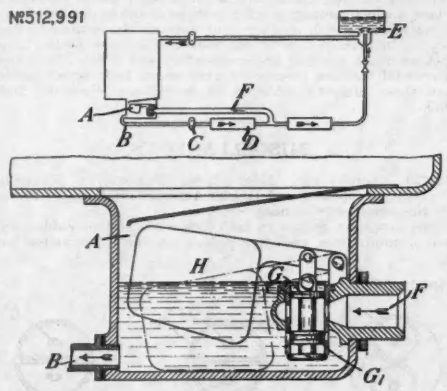


main oil sump is provided with a small auxiliary oil sump A having an outlet B to a scavenge pump C. Oil is drawn by the scavenge pump from the sump and passes through a filter D, after which it is passed through a cooler and into a reservoir tank E, from which it is pumped into the engine. Oil is by-passed through a pipe F from the delivery side of the scavenge pump to the sump. The rate of flow through the by-pass pipe is controlled by the oil level in the sump by a float controlled piston valve, which maintains the level of oil in the sump sufficiently above the level of the outlet pipe B to exclude air from being drawn into the scavenge pump. The valve consists of two pistons G and $G_1$ in a ported cylinder. The piston $G_1$ acts as the movable valve member to cover and uncover outlet ports in the cylinder, while G serves as the balancing piston. Incoming oil flows through an annular duct and inlet ports into the body of the valve and through the outlet ports into the sump when the ports are uncovered by the piston $G_1$. Upward movement of the valve member is limited by means of a flange formed on an extension of the stem, which comes into contact with the end of the cylinder. The upper end of the valve stem is extended to a link which is coupled to a lever connected at one end to a float H. The other end of the lever is pivoted to a fulcrum. Any slight deviation in the oil level in the sump from a mean position causes the piston valve under the action of the float to regulate the amount of opening of the outlet ports and thereby modifies the rate of flow of the by-pass oil to the sump until the mean oil level has been restored.—*October 2nd*, 1939.

## TRANSFORMERS AND CONVERTERS

512,788. March 14th, 1938.—THREE-PHASE ELECTRIC TRANSFORMER AND/OR CHOKING COIL ARRANGEMENTS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This invention relates to three-phase electric transformers and/or choking coil arrangements and is concerned with the balancing out of harmonics in such arrangements when individual transformers or choking coils have fundamental flux systems which asymmetrically load the individual phases with harmonics of different value. The arrangement shown comprises a group of six choking coils and/or transformers operating in parallel and supplying harmonics which mutually balance out, secondary windings (when provided) being omitted. Transformers 1, 2, and 3 are connected in star and provided with mains connections U, V, W. The mains connections U, V, W of the three transformers are so connected to the phases R, S, T of the mains that the central transformer phase V, that is to

№512,788

say, the winding on the central limb of the first transformer 1, is connected to the central mains phase S, the phase V of the second transformer 2 is connected to the mains phase T, and the phase V of the third transformer 3 is connected to the mains phase R. The transformers 1 to 3 are supplied with harmonics of 6 $n \pm 1$ times the fundamental frequency by three transformers 4, 5, and 6 of equal power, which are connected in delta or in zig-zag. The two transformers 4 and 5 may be connected in delta and the third transformer 6 may be connected in zig-zag. Here again, the mains connections are so interchanged that, for example, the winding V on the central limb of the transformer 4 is connected to the mains phases S and T, the winding V of the transformer 5 is connected to the mains phases T and R and the winding V of the transformer 6 is connected directly to the mains phase R and through other windings to the mains phases T and S.—*September 26th*, 1939.

512,789. March 14th, 1938.—CONTROL OF THE HARMONICS IN POLYPHASE ALTERNATING CURRENT SYSTEMS, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This invention concerns the control of the harmonics in polyphase alternating current systems which are asymmetrically loaded with harmonics due, for example, to transformers or choking coils which produce harmonics of different values in the several phases. In the arrangement shown in Fig. 1, the main windings A are connected in delta. The phase B on the central limb which has smaller harmonics than the other phases is, according to the invention, additionally loaded by a highly saturated single-phase choking coil C. The magnetising current of the choking coil C may amount to about one-third per cent.

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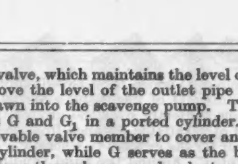


Fig.1

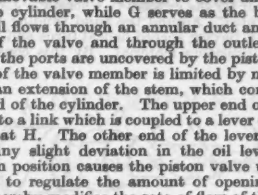


Fig.2

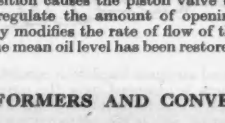


Fig.3

of the total magnetising current of the main transformer if the magnetising current of the main transformer is equal to about 2 per cent. of the total current. In the arrangement shown in Fig. 2, the single-phase choking coil C is connected to a delta-connected tertiary winding D of the main transformer, the primary winding B of which is connected in star. The winding D may also be a secondary winding of the transformer and may at the same time supply power. By connecting the choking coil C to the transformer winding to be balanced, greater freedom is obtained in the design of the choking coil, as the voltage may be adjusted to the most favourable value. This way of coupling the choking coil to the transformer is also advantageous if the neutral point of a star-connected arrangement is not accessible. If the choking coil is to be used with a star-connected transformer having main windings with an accessible neutral point, the circuit arrangement shown in Fig. 3 is employed. There are two other diagrams.—*September 26th*, 1939.

## TRANSMISSION OF POWER

512,968. March 26th, 1938.—ELECTRIC AIR-SPACE-INSULATED LINES OR CABLES, Siemens & Halske Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

In accordance with an example of a cable described in this specification, an inner conductor is formed of two continuous trough-like bands A and B having outwardly pressed recesses

in the form of grooves C which form two discontinuous helical ribs. A band winding D of insulating material, for example polystyrol, is applied directly over the grooves C. The band winding D is held at a suitable distance from the main part of the inner conductor by the grooves C, whereby a good air-space insulation is provided. Around the band winding D is wound a thread winding E having spaced helical turns and around this a covering F of insulating material. By this construction, a

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high-grade electrical air-space insulation consisting of two layers is produced. There is arranged over the covering F a return conductor G, which is also formed of trough-like bands provided with grooves, around which are arranged successively a band winding H and a cable jacket J. If desired the grooves C may be arranged to form a continuous helical rib, or they may form a series of longitudinally spaced annular ribs, or a series of longitudinally displaced semi-annular ribs.—*September 29th*, 1939.

## LIGHTING AND HEATING

512,500. March 17th, 1938.—DIRECTIONAL LIGHTING FITTINGS, The General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C.2., and John Bernard Score Smyth, of Research Laboratories of The General Electric Company, Ltd., Wembley, Middlesex.

This invention relates to directional lighting fittings of the type comprising a reflector (without refractors) adapted to redirect the light from a source so that, in a vertical plane through the source, the light intensity is a maximum in some preferred direction between the horizontal and a line 30 deg. below the horizontal. Such fittings are much used in street lighting, the direction being then some 5 deg. or 10 deg. below the horizontal. The reflector often consists of a pair of paraboloidal wings, one on each side of the source, the source being at the common focus and the axes of the wings in the preferred direction on either side of the source. The two wings are often made of silvered glass as a single unit. Recently the Ministry of Transport has formulated recommendations according to which in a certain class of streets the ratio of the maximum intensity in the preferred direction to the mean intensity between two cones, with vertical axes through the source and with their sides inclined at 30 deg. and 45 deg. respectively to the vertical, is not to exceed 4. Many existing fittings of the type described do not fulfil this condition. The object of the invention is to provide a cheap and convenient method of bringing within these recommendations fittings in which the ratio is greater than 4. In a directional lighting fitting of the

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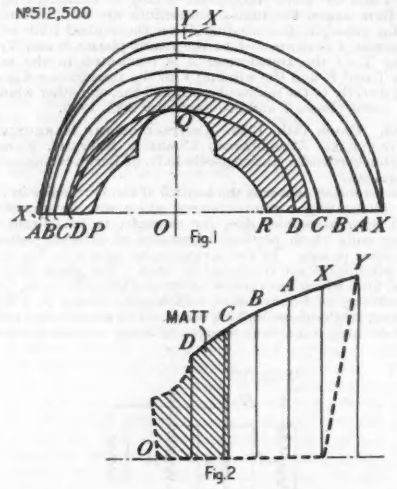


type specified wherein the ratio does not exceed 4, part (considerably less than the whole) of the surface of the reflector is substantially matt and is so shaped that, if it were specularly reflecting, the ratio would exceed 4. It has been found greatly preferable to decrease the ratio by making one part of the surface substantially matt, and to leave the remainder specularly reflecting, than to make the whole surface slightly diffusing. Fig. 1 is a view of a known reflector, consisting of paraboloidal wings, looking into one of the wings in a horizontal direction, and Fig. 2 is a section in a vertical plane containing the direction of view. In Fig. 1, O is the position occupied by the source, the line XYX is the contour of the outer edge of the wing, the line PQR the inner edge of the wing where it joins the wing on the other side of the source; the line PQR is in a vertical plane, but the point Y projects somewhat further from the source than the point X. The lines $XX^1X$, AA, BB, CC, DD are the lines in which a set of equidistant vertical planes intersect the wing. The arrangement of these planes is shown in Fig. 2 which is a section of the wing by a vertical plane containing OY and perpendicular to the plane of Fig. 1. The contour DCBAXY in Fig. 2 is parabolic. In the unmodified fitting, the whole of the silvered surface is specularly reflecting but furnished with shallow flutes to prevent irregular concentrations of light. The aforesaid ratio is then about 7. It was modified, according to the invention, by sand-blasting that part of the outer surface of the reflector which is shaded in Figs. 1 and 2 before this outer surface, including the sand-blasted part, was silvered. The silvered sand-blasted portion was then substantially matt; it constituted about $\frac{1}{4}$ of the whole reflecting surface; the said ratio was then found to be about 3·8.—*September 18th*, 1939.

512,695. March 16th, 1938.—TEMPERATURE CONTROL OF ELECTRICALLY HEATED OVENS, The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C.2, and Frederic Horton Clough, of The Old Rectory, Clay Coton, Northamptonshire.

This invention concerns methods of controlling the temperature in electrically heated ovens such as are used for domestic cooking or for the industrial treating of various substances. The accompanying drawing diagrammatically illustrates this invention. In it the supply mains A and B are electrically connected to the heating unit C through an electro-magnetically controlled switch D. The winding E of this switch is connected in series with a stationary contact F which is common to a plurality of normally closed thermostatic switches G which are connected to the supply line A through a selector switch H. In operation when a particular temperature is required in the oven, the selector switch H is moved to the position in which the thermostat G corresponding to this temperature is connected in the control circuit. This completes the circuit of the operating coil E of the electro-magnetic switch D in the heating circuit and retains the switch in its closed position until the thermostat opens, when the desired temperature is reached. The opening of the thermostat breaks the circuit of the coil E of the electro-magnetic switch which opens and breaks the circuits of the heating units C. The electro-magnetic switch is preferably of the quick break micro-gap type as this takes the current of the heating circuit. As the

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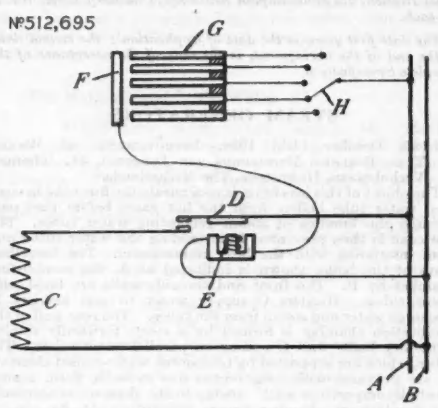


thermostatic switches, which are preferably of the bi-metallic type, only carry the control circuit current detrimental arcing will not occur at their contacts as this current need not exceed a few milliamperes. In practice the thermostatic switches may be mounted in a small casing in the wall or roof of the oven the selector switch being arranged at a convenient point outside the oven, where it can be readily adjusted. The electro-magnetic switch may also be mounted at any convenient point, but as this does not need to be adjusted after being put into service it does not require to be put in a position where the operator can get at it easily.—*September 22nd*, 1939.

512,791. March 15th, 1938.—GAS-FILLED INCANDESCENT ELECTRIC LAMPS, Société Anonyme pour les Applications de l'Electricité et des gaz Rares Etablissements Claude-Paz & Silva, of 8, Rue Cognacq-Jay, Paris, France.

This invention relates to gas-filled incandescent lamps of small volume. The lamp bulb has coiled coil tungsten filaments and is filled with a mixture of approximately 98 per cent. of xenon and 2 per cent. of nitrogen. There are two foot tubes A, B, welded at C, D, to the main portion of the bulb. These foot tubes carry coiled coil tungsten filament elements E, F, consuming 50 watts at 55 volts, supported by lead-in wires passing through the pinches. These two filaments are connected in series by a nickel conductor G which is outside the lamp and is located in an outer bulb H against the upper portion of which it

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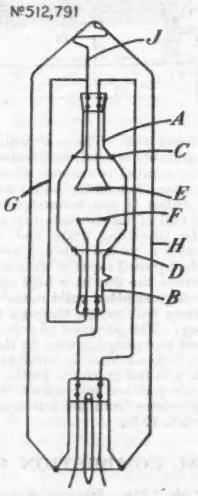


is held by a doubly bent rod J. This outer bulb can be made of such a size that it does not reach too high a temperature and can also, if desired, be filled entirely with a cooling fluid. It can be made of frosted opal or enamelled or coloured glass. The inner bulb is thus protected from knocks and can be made of very thin glass, which will reduce the absorption of the infra-red. This mounting with two foot tubes and two filaments connected by an external conductor is particularly interesting in lamps which contain much xenon, as it allows of a reduction of the nitrogen with a consequent appreciably increased efficiency. The combination of the use as filling gas for the lamp of gases which are bad heat conductors and of the above constructional features permits of very small bulb sizes, smaller than those hitherto achieved or described.—*September 26th*, 1939.

## MISCELLANEOUS

512,670. March 3rd, 1938.—HIGH FREQUENCY ELECTRIC CABLES, Siemens und Halske Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This invention relates to high frequency electric cables with two or more lines each comprising an inner conductor sur-

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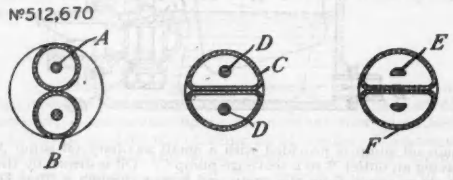


rounded by an outer conductor, preferably with air-space insulation, and has for its object to reduce the consumption of material and the cost of production. According to the invention the outer conductors of the several lines of a high frequency cable have a semi-circular or sector-shaped cross-section, the lines being combined to form a cable of substantially circular cross-section. With this construction the cross-sectional area of the outer conductor is reduced as compared with that obtained with a conductor of circular cross-section having the same attenuation. The drawing, Fig. 1, shows diagrammatically in cross-section a known type of a high frequency cable with two lines, each of which has an outer conductor with a circular cross-section. The inner conductors are shown at A and the outer conductors at B. Fig. 2 shows a high frequency cable with two lines constructed in accordance with the invention. The outer conductors C have a semi-circular cross-section, whilst the inner conductors D are round, the two lines being so placed adjacently to each other that the cable as a whole has a circular cross-section. In the example shown in Fig. 3 the inner conductors E have a cross-sectional shape corresponding to that of the outer conductors F, *i.e.* a semi-circular cross-section. Other constructions are described.—*September 23rd*, 1939.

## Forthcoming Engagements

*Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the* TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

### Fuel Luncheon Club

*Thursday, Dec. 7th.*—Connaught Rooms, Great Queen Street, W.C.2. "Possible Fuels," A. C. G. Egerton. 12.40 for 1.10 p.m.

### Institution of Automobile Engineers

*Tuesday, Dec. 12th.* Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. "The Use of Gas as a Fuel for Motor Vehicles," Dr. J. S. Clarke. 6 p.m.

### Institution of Chemical Engineers

*Tuesday, Dec. 12th.*—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "Principles of Gas Compressor Design," D. M. Newitt. 2.15 p.m.

### Institution of Civil Engineers

*Saturday, Dec. 9th.*—Yorkshire Assoc. Hotel Metropole, Leeds. "The York Passenger Station Extensions," H. Ormiston. 2.30 p.m.

### Institution of Electrical Engineers

*Monday, Dec. 4th.*—S. Midland Students' Section. James Watt Memorial Institute, Great Charles Street, Birmingham. Problems Evening. 7 p.m.

### Institution of Locomotive Engineers

*Thursday, Dec. 14th.*—Waldorf Hotel, Aldwych, W.C.2. Presidential Address, O. V. S. Bulleid. 2.30 p.m. (Luncheon for Members at 12.30 for 1 p.m.).

### Institution of Engineers and Shipbuilders in Scotland

*Tuesday, Dec. 19th.*—39, Elmbank Crescent, Glasgow, C2. "Humps and Hollows in Curves of Resistance," A. M. Robb. 6.30 p.m.

### Institute of Fuel

*Friday, Dec. 15th.*—Geological Society's Rooms, Burlington House, Piccadilly, W.1. "Improvement in Calorific Value of Town's Gas or Coke Oven Gas with special reference to Utilisation as a Fuel for Motor Vehicles," J. I. Graham and D. G. Skinner. 2.15 p.m.

### Institution of Structural Engineers

*Saturday, Dec. 2nd.*—Yorkshire Branch. Hotel Metropole, Leeds. "Coastal Erosion and Defence Works," G. McLean Gibson. 2.30 p.m.

### Institute of Transport

*Monday, December 11th.*—Charing Cross Hotel, London, W.C.2. Annual General Meeting. Address by Rt. Hon. Euan Wallace, M.P., Minister of Transport. 2.30 p.m.

### North-East Coast Institution of Engineers and Shipbuilders

*Saturday, Dec. 2nd.*—Student Section. Bolbec Hall, Newcastle-upon-Tyne. "From the Shipowner's Point of View," T. Russell Cairns. 2.30 p.m.

### Royal Institution of Great Britain

*To-day, Dec. 1st.*—21, Albemarle Street, W.1. "Infra-Red Spectra," W. H. J. Childs and H. A. Jahn. 2.30 p.m.

*Monday, Dec. 4th.*—21, Albemarle Street, W.1. General Meeting. 3 p.m.

*Wednesday, Dec. 6th.*—21, Albemarle Street, W.1. "Magnetism and the Structure of Matter," K. Lonsdale. 2.30 p.m. "Transmission of Radio Waves through the Atmosphere," E. V. Appleton. 5.15 p.m.

*Thursday, Dec. 7th.*—21, Albemarle Street, W.1. "History of the Vacuum Flask," Sir William Bragg. 2.30 p.m.

*Friday, Dec. 8th.*—21, Albemarle Street, W.1. "Infra-Red Spectra," W. H. J. Childs and H. A. Jahn. 2.30 p.m. "Transmission of Radio Waves through the Atmosphere," (II), E. V. Appleton. 5.15 p.m.

## CATALOGUES

HOLOPHANE, Ltd., Elverton Street, London, S.W.1.—List of special lighting fittings for A.R.P.

RUSTON AND HORNSBY, Ltd., Lincoln.—Catalogue dealing with the firm's marine auxiliary oil engines.

DELCO-REMY AND HYATT, Ltd., 111, Grosvenor Road, London, S.W.1.—Price-lists of electric motors and fans.

WILLIAM ASQUITH, Ltd., Halifax.—Details of the design and construction of the horizontal drilling, boring, and milling machines made by the firm.

RAYBESTOS-BELACO, Ltd., Asbestos House, Southwark Street, London, S.E.1.—Solutions to more than a hundred problems commonly encountered in brake and clutch design and operation.

H. AND J. QUICK, Ltd., Chester Road, Old Trafford, Manchester, 16.—A small brochure illustrating and describing a commercial truck or lorry which can be rapidly converted into an ambulance or a fire tender.

HOLMAN BROS., Ltd., Camborne.—New catalogue of rock drills for mining, quarrying, civil engineering works, &c. In addition to describing the construction of the drills many illustrations are given of typical works upon which they are employed.

HENRY LINDSAY, Ltd., 47, Queens Road, Bradford.—Mechanical power transmission catalogue describing speed variers, friction clutches, belt shifters, and vee-rope drives; and a descriptive catalogue illustrating the "Lindapter" bolt adapters and their uses.